te technical note techn

National Convective Weather Forecast (NCWF) 1999 Assessment Report

Danny Sims

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

June 2001

DOT/FAA/CT-TN00/23

Document is on file at the William J. Hughes Technical Center Library, Atlantic City International Airport, NJ 08405

U.S. Department of Transportation
Federal Aviation Administration
William J. Hughes Technical Center
Atlantic City International Airport, NJ 08405

NOTICE

This document is disseminated under the sponsorship of the U.S. Department of Transportation in the interest of information exchange. The United States Government assumes no liability for the contents or use thereof.

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the objective of this report.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/CT-TN00/23		

4. Title and Subtitle	5. Report Date
National Convective Weather Forecast (NCWF) 1999 Assessment Report	June 2001
	6. Performing Organization Code: ACT-320

7. Author(s)	8. Performing Organization Report No.
Danny Sims; Cynthia Fidalgo, Raytheon	DOT/FAA/CT-TN00/23

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
U.S. Department of Transportation Federal Aviation Administration William J. Hughes Technical Center Atlantic City International Airport, NJ 08405	11. Contract or Grant No.
	13. Type of Report and Period Covered: Technical Note
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration William J. Hughes Technical Center Atlantic City International Airport, NJ 08405	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The report summarizes the National Convective Weather Forecast (NCWF) 1999 Assessment conducted by ACT-320 at Comair and Delta Airlines from April through November 1999. The NCWF, developed by scientists at the National Center for Atmospheric Research (NCAR), combines radar information along with lightning data to produce a graphical convective detection field as well as 1- and 2-hour forecasts of convective weather. Feedback was collected from airline dispatchers and focused on the value, preceived benefit, and performance of the NCWF for airline dispatch use. The assessment demonstrated the utility of the NCWF for airline dispatch operations. However, further development should concentrate on improved accuracy of the forecasts. In addition, convective growth and decay capabilities should be incorporated.

17. Key Words	18. Distribution Statement
National Convective Weather Forecase (NCWF) National Center for Atmospheric Research (NCAR) Convective Weather, Thunderstorms, Airline Dispatcher	This document is available to the public through the Technical Center Library, Atlantic City International Airport, NJ 08405

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	89	

ACKNOWLEDGEMENTS

The National Convective Weather Forecast (NCWF) 1999 Assessment Report is the summation of a collaborative effort that involved the participation of several different agencies. The participation of Comair and Delta Airlines is acknowledged. Airline dispatchers at both airlines provided valuable feedback. Specific acknowledgement should be given to John Burrows, Duty Manager of Flight Operations at Comair, and Truman Tinsley, Manager of Flight Control Standards and Training at Delta Airlines, who ensured coordination of dispatcher feedback at each respective airline. In addition, acknowledgement goes to Cindy Mueller, Dan Meganhardt, and Nancy Rehak at the National Center for Atmospheric Research (NCAR). These individuals were responsible for the development and maintenance of the NCWF, assisted with the development of assessment plans, conducted training of airline dispatchers, and provided reviews of this report.

TABLE OF CONTENTS

APPENDIXES

LIST OF ILLUSTRATIONS

LIST OF TABLES

EXECUTIVE SUMMARY

This report summarizes the National Convective Weather Forecast (NCWF) 1999 Assessment conducted at Comair and Delta Airlines from April through November 1999. Specific results, conclusions, and recommendations for the assessment are detailed within this report.

The Research Applications Program at the National Center for Atmospheric Research (NCAR/RAP) has developed the NCWF to provide graphical information regarding the current and short-term forecast location of thunderstorm activity. The NCWF combines radar information along with lightning data to produce a convective detection field as well as 1- and 2-hour forecasts of convective weather.

The Federal Aviation Administration (FAA) William J. Hughes Technical Center, Weather Branch (ACT-320) conducted an assessment of the NCWF. The assessment involved aircraft dispatch personnel at Comair and Delta Airlines, working in their respective operational environments. The assessment focused on the value, perceived benefit, and performance of the NCWF for airline dispatch use, in addition to collecting information on enhancements made by NCAR/RAP from previous versions of the NCWF. ACT-320 personnel collected user feedback through a variety of means including questionnaires, interviews, operational observations, and Internet-based user logs.

Assessment results indicated the NCWF was useful to airline dispatch operations. The graphical representation of both real-time and forecast convection was helpful. The NCWF was useful when viewed as an additional piece of information rather than as a stand-alone product. However, issues regarding the forecast accuracy, especially the 2-hour forecast, lessened the NCWF's value.

Dispatchers identified that the NCWF provided benefit to most of their job tasks and decisions. These included preparing flight plans, planning flight routes, avoiding severe weather, selecting alternate airports, selecting altitudes, monitoring flight conditions, rerouting flights, and advising pilots enroute of severe convective weather.

Overall readability ratings for the NCWF graphical interface and characteristics were acceptable. However, larger annotations, less clutter, and improved zoom functions were identified as desired improvements.

From the dispatchers' perspective, the accuracy of the NCWF forecasts needs improvement. While it was identified that the 1-hour forecast only needed minor improvements, a significant portion of the users found the 2-hour forecast unacceptable. It was noted that the NCWF appears to handle large, organized storms in an accurate manner; however, the performance with smaller, air mass storms is not as good.

Several enhancements were identified that would further increase the utility of the NCWF. The most frequently noted enhancements included animation, growth and

decay of convective areas, larger graphics and text, improved zoom capability, and additional overlays.

The assessment demonstrated the utility of the NCWF for airline dispatch operations. However, further development should concentrate on improved accuracy of the forecasts, especially the 2-hour forecast. Convective growth and decay capabilities should also be incorporated.

1. INTRODUCTION.

1.1 BACKGROUND.

Thunderstorms are a cause of national airspace delays during the summer season. Thunderstorm phenomena such as lightning, turbulence, hail, icing, and poor visibility require airspace users to provide a wide margin of separation between these phenomena and aircraft operations. In order to help avoid these phenomena, reliable detection and forecasts of convective activity are required.

In response to the need for detection and forecasts, the Federal Aviation Administration (FAA) Aviation Weather Research Program (AWRP) has sponsored the development of prototype convective weather products for both the terminal and enroute environments. For the enroute environment, the National Center for Atmospheric Research (NCAR) Research Applications Program (RAP), working as part of the AWRP Convective Weather Product Development Team, has developed the National Convective Weather Forecast (NCWF). The NCWF provides graphical information regarding the current and short-term forecast location of thunderstorm activity.

The FAA William J. Hughes Technical Center Weather Branch (ACT-320) previously assessed two developmental versions of the NCWF. The first was assessed during the summer of 1997, as the Automated Convective SIGMET Forecast (ACSF) Product. The ACSF provided a 1-hour forecast of convective activity. During the assessment, convective forecasters at the National Oceanic and Atmospheric Administration (NOAA) Aviation Weather Center (AWC) used the product as a tool to aid in creating Convective Significant Meteorological Statements (SIGMET). Results revealed that some components of the product had merit; however, specific improvements would be required in order to make it useful for SIGMET generation. Assessment results are documented in the Automated Convective SIGMET Forecast Product Demonstration Summary Report, December 1997 (available from ACT-320).

The second assessment of the product, renamed the NCWF, occurred during the summer of 1998, and involved a usability study using aircraft dispatch personnel from two major and one regional airlines: (1) Delta Airlines, (2) Northwest Airlines, and (3) Atlantic Coast Airlines, respectively. Overall results indicated that the NCWF was valuable in identifying and forecasting convective weather; was useful in performing job tasks; and performed well, particularly with well-defined frontal weather situations. In addition, potential improvements and enhancements were identified. ACT-320 documented the results in the National Convective Weather Forecast (NCWF) Product Demonstration Final Report, October 1999.

The 1999 iteration of the NCWF included interface and algorithm changes, most notably, interactive zoom capabilities and the addition of a 2-hour forecast. In order to ascertain the value and performance of the updated NCWF, a third assessment was conducted. This third operational assessment included airline dispatchers from Comair

and Delta Airlines utilizing the NCWF at their respective airline dispatch operation centers. The 1999 assessment is the focus of this report.

1.2 PURPOSE OF REPORT.

The purpose of this report is to document the results of the 1999 NCWF Assessment concerning the value and performance of the NCWF for airline dispatch use.

1.3 SCOPE.

This report will summarize assessment conduct and results. The report will describe the NCWF, assessment objectives, methodology, location, participants, results, conclusions, and recommendations. The scientific and meteorological aspects (including accuracy) of the NCWF are being addressed separately by NCAR and are not a part of this report.

2. REFERENCE DOCUMENTS.

a. FAA Acquisition Management System Test and Evaluation Process Guidelines, June 1999.

b. FAA-Standard-024B, Content and Format Requirements for the Preparation of Test and Evaluation Documentation, August 22, 1994.

c. Automated Convective SIGMET Forecast (ACSF) Product Demonstration Summary Report, December 19, 1997; ACT-320.

d. National Convective Weather Forecast (NCWF) Product Demonstration Final Report, October 19, 1999; ACT-320.

e. National Convective Weather Forecast (NCWF) Assessment Plan, June 4, 1999; ACT-320.

f. National Convective Weather Forecast (NCWF) Assessment Procedures, July 15, 1999; ACT-320.

3. SYSTEM DESCRIPTION.

3.1 SYSTEM OVERVIEW.

3.1.1 NCWF Operations.

The NCWF software ran at NCAR/RAP. Output was produced every 5 minutes and placed on the NCAR web server. Access to the NCWF was via the Internet using the web address of http://ncwf.rap.ucar.edu. NCAR/RAP maintained the running of the NCWF; however, since they are not a 24-hour per day, 7-day per week facility, it was

recognized that reliability could be an issue, especially on weekends and during night hours.

Comair dispatchers viewed the NCWF on dedicated computers located in the dispatcher work areas while participating Delta Airlines dispatchers used personal laptop computers. In order for the NCWF to be viewed correctly either Netscape 4.06 or Internet Explorer 4.0 or higher was necessary as the Internet browser. The 1998 version of the NCWF could be viewed with Netscape 3.0 or Internet Explorer 3.0 or higher.

3.1.2 Detection Field.

The NCWF determines the locations of convective weather from the integration of lightning and radar data. The data sources for the NCWF are the Composite Base Reflectivity and Echo Top Mosaics from Weather Services International (WSI), and National Lightning Detection Network (NLDN) data from Global Atmospherics, Inc. received via Kavouras. This data goes through numerous steps before becoming the final NCWF detection field: a two-dimensional 4 kilometers (km) spatial resolution convective field that updates automatically every 5 minutes.

The chronological steps in determining the detection field are summarized in the following paragraphs. NCAR/RAP should be contacted for more detailed information.

a. The 2-km National Composite Base Reflectivity and 4-km Echo Tops from WSI are converted into a 4-km resolution grid field.

b. A filter process removes data with echo tops less than 17,000 feet in order to eliminate most ground clutter and nonconvective activity.

c. A convection detection field value between 1 and 6 is assigned to each grid point based upon the remaining reflectivity data and lightning strike information. Lightning information is used to either increase the detection field value of existing reflectivity areas or to add areas that are without any reflectivity data.

3.1.3 Forecast Products.

After obtaining the detection field, another series of steps are taken to identify potentially long-lived storms and to provide these areas with 1- and 2-hour forecasts depending upon the following criteria.

a. A scale separation filter is applied to the detection field to eliminate small-scale features that are perishable within an hour. This allows the tracking of the storm envelope instead of individual cells.

b. A tracking algorithm, Thunderstorm Identification Tracking and Nowcasting (TITAN), runs on the filtered field to determine storm motion. TITAN defines a storm

based on contiguous regions and uses a centroid tracker technique for providing forecasts based upon storm track and trend.

c. The storm system must meet all of the following thresholds before a 1-hour forecast is produced:

1. Detection field level 3 or greater;
2. Area coverage of 520 km^2 or greater;
3. Existed for at least 45 minutes.

d. An additional filter is applied to the individual 1-hour forecasts to determine if a 2-hour forecast should be calculated. This filter is based upon the maximum average and standard deviation of the detection fields. Larger and more intense storms are characterized by higher maximum averages but lower standard deviations. These storms receive a 2-hour forecast based upon TITAN. The larger storms are more likely to be accurately forecasted by the NCWF.

It should be noted that a NCWF convective area without a forecast does not mean the area is not moving or will not persist for 1 or 2 hours. Some convective regions may not meet one or more of the above stated criteria for producing a forecast.

3.2 NCWF COMPONENTS AND FEATURES.

Figure 1 illustrates an example of the NCWF. Various components and features of the system are described in the following sections.

3.2.1 Components.

3.2.1.1 Initial Detection Field.

The Initial Detection Field (figure 1, item 1) displays the convective intensity based on the comparison of the base reflectivity and lightning rate fields. This field is displayed using a 6-level intensity color scale. The field may be toggled on and off by clicking the Detection field box in the Products section at the top of the display.

3.2.1.2 Convective Intensity Color Scale.

The Convective Intensity Color Scale (figure 1, item 2), located on the right of the display, indicates the intensity level of the convective detection field with the highest levels (5-6) as red; moderate levels (3 and 4) as yellow and orange, respectively; and lowest intensity levels (1-2) as green..

National Convective Weather Forecast *(EXPERIMENTAL)*

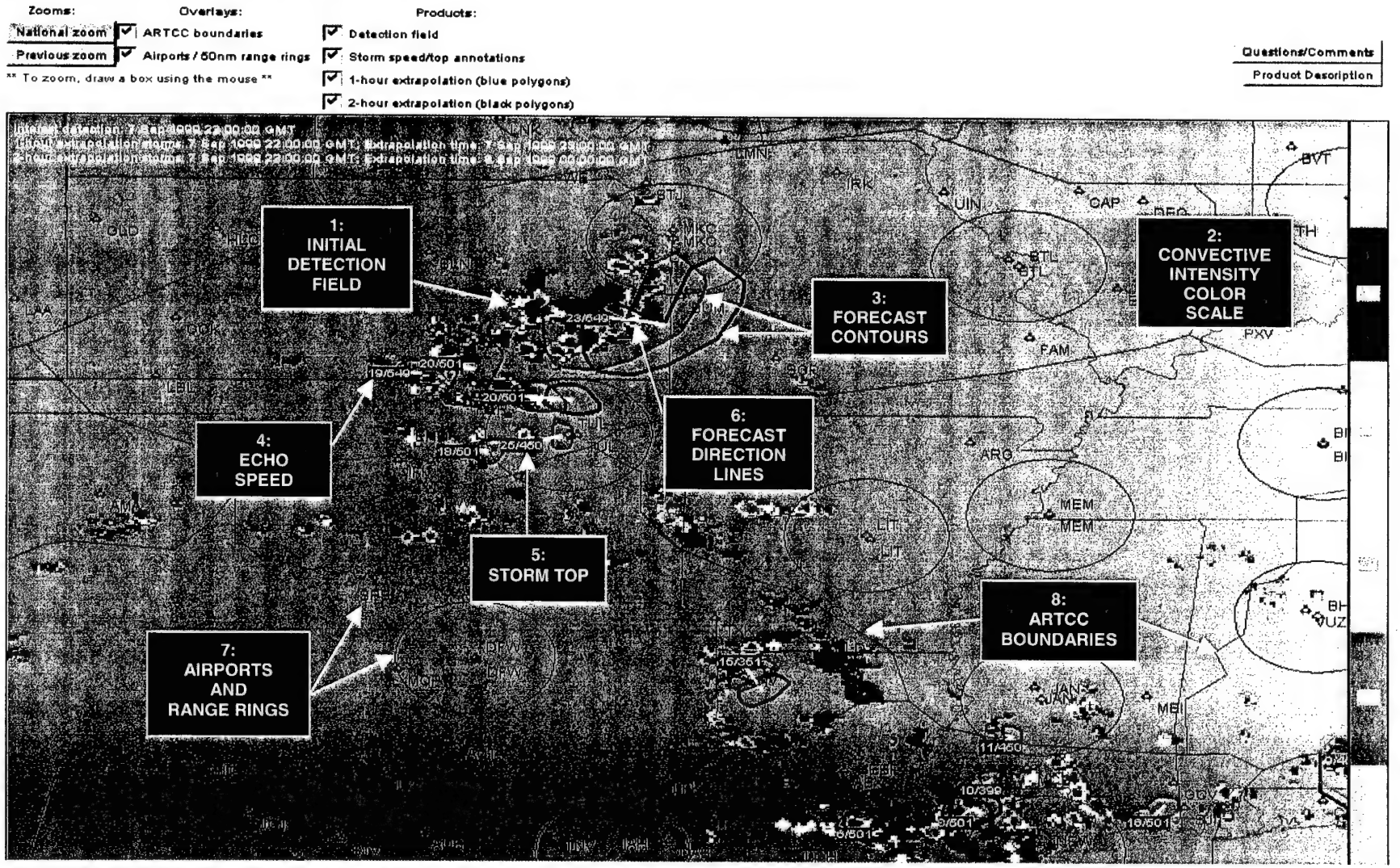


FIGURE 1. NCWF DISPLAY

3.2.1.3 Forecast Contours.

Forecast Contours (figure 1, item 3) are represented as blue (1 hour) and black (2 hour) colored polygons. Forecast contours may be toggled on or off by clicking the appropriate box in the Products section at the top of the display.

3.2.1.4 Echo Speed.

Echo Speed (figure 1, item 4) is annotated in knots over the detection areas that have forecast contours. The Echo Speed precedes the Storm Top information (section 3.2.1.5). Echo Speed may be toggled on and off by clicking the box labeled "Storm speed/top annotations" in the Products section at the top of the display.

3.2.1.5 Storm Top.

Storm Top (figure 1, item 5) is annotated in hundreds of feet following the Echo Speed. Storm Top is toggled on and off along with the Echo Speed (see section 3.2.1.4).

3.2.1.6 Forecast Direction Lines.

Forecast Direction Lines (figure 1, item 6) are displayed as white lines or vectors, indicating the direction of storm movement. These lines are displayed only when the forecast contours are displayed.

3.2.2 Features.

3.2.2.1 Views.

Users may select a national view to observe the contiguous United States, or they may zoom in on smaller regions by using the mouse to draw a selection box around the area of interest. The user may return to the previous zoom or national zoom by clicking the appropriate buttons located in the upper left corner of the display.

3.2.2.2 Overlays.

Overlays on the NCWF include airports (using the 3-letter identifier), range rings (figure 1, item 7) and Air Route Traffic Control Center (ARTCC) boundaries (figure 1, item 8). The airport identifiers also include selected Navigation Aid (NAVAID) sites, for example, Very High Frequency (VHF) OmniRange Navigation System (VOR) sites. The range rings encompass a radius of 50 nautical miles (nmi) around major airports. Due to the map projection used for the NCWF, the range rings appear as slight ovals, rather than as exact circular rings. The ARTCC boundaries delineate areas of responsibility for each of the individual centers. The airports and range rings are displayed with each other and may be toggled on and off, while the ARTCC boundaries may be separately

toggled on and off using the boxes provided at the top of the display. State boundaries are a permanent overlay.

3.2.3 NCWF Changes for 1999.

Changes from earlier versions of the NCWF to the 1999 NCWF were based on prior user feedback as well as scientific improvements to the algorithm. Changes and enhancements included the following:

a. Use of composite reflectivity data rather than Vertically Integrated Liquid (VIL) data previously used.

b. Addition of a 2-hour forecast, with the option of users selecting either the 1- or 2-hour forecast option.

c. Smoothing of forecast polygons.

d. User selected zoom capability replacing preset selections for national, regional, and ARTCC views.

e. More rapid graphical updates.

f. User selected overlay options of ARTCC boundaries, airports, and 50 nmi range rings.

4. ASSESSMENT DESCRIPTION.

4.1 ASSESSMENT OBJECTIVES.

The NCWF assessment was conducted to assess the value, perceived benefit, and performance of the latest version of the NCWF for airline dispatch use. Specific objectives were:

a. Assess the value of the NCWF in identifying and forecasting convective weather for airline dispatch use.

b. Identify NCWF benefit areas for dispatcher tasks and decisions.

c. Assess product graphical interfaces and characteristics.

d. Assess NCWF performance and accuracy from the dispatchers' perspective.

e. Identify enhancements.

4.2 ASSESSMENT ACTIVITIES.

4.2.1 Assessment Participants.

4.2.1.1 Delta Airlines.

Delta Airlines is one of the country's largest airlines, employing over 140 dispatchers in their operations center. Their route structure covers the contiguous United States. NCWF Assessment participants were a sub-group of dispatchers who had access to the 1999 version of the NCWF (see section 4.2.2.2). Delta Airlines dispatch operations are supported by a staff of company meteorologists with access to considerable weather information. Delta was a participant in the 1998 assessment.

4.2.1.2 Comair.

Comair is one of the largest regional airlines and operates nearly 700 daily flights covering the eastern half of the country. A staff of approximately 50 dispatchers are employed in their operations center. All Comair dispatchers were able to participate in the NCWF assessment. Unlike Delta Airlines, Comair does not maintain its own meteorology staff. Regional airlines typically lack the myriad weather information sources available to dispatchers in most major airlines. Comair was not a participant in previous NCWF assessments.

4.2.2 Pre-assessment Conduct Activities.

4.2.2.1 Baseline Measures.

ACT-320 personnel through the use of interviews and observations identified current procedures and information sources used by dispatchers at Comair in detecting and forecasting convective weather. The information was documented (see appendix A) and provided a basis for comparison between current methodologies and use of the NCWF. The baseline data was collected June 1-2, 1999. In order to avoid bias, the baseline data was collected before introduction of the NCWF to Comair users.

Baseline information for Delta Airlines was collected for the 1998 NCWF Assessment. There was no need to collect additional information for the 1999 assessment.

4.2.2.2 Product Implementation.

In order for Comair dispatchers to view the NCWF, NCAR personnel provided and installed four dedicated computers in the dispatcher operations area. Each of the computers was attached to an Internet Service Provider for viewing of the NCWF on an NCAR developed web page. The computer monitors were in viewing distance from each dispatcher's individual work position. Since displays were shared, the displays could be turned toward particular dispatchers and away from others. In addition,

dispatchers had to share a keyboard and mouse for each display, thereby limiting individual interactive capability.

Delta Airlines had Internet access via its Local Area Network. However, the Internet browser used at Delta was unable to display the 1999 version of the NCWF. Thus, it was decided that a sub-group of 10 dispatchers (Subject Matter Experts) would be utilized for formal feedback. This group of dispatchers used personal laptop computers at their dispatcher work locations with an appropriate Internet browser to allow them to view the 1999 NCWF. In addition, two dispatcher positions (for Delta Express flights) had company-provided computers with the ability to display the 1999 NCWF. All other Delta dispatchers only had access to the 1998 version of the NCWF and were not included in the collection of feedback.

4.2.2.3 Product Training.

All product training was provided by NCAR. On-site training was provided to the Delta Airline dispatchers participating in the assessment. On-site individual training of dispatchers plus a train-the-trainer approach of key Comair personnel accomplished Comair training.

4.2.2.4 Product Shakedown.

After product activation at both Delta Airlines and Comair, time was allocated for product shakedown to ensure proper meteorological and web page performance. This also provided users with additional product familiarization prior to official assessment conduct. Delta Airlines had approximately 2 months for shakedown while Comair had approximately 1 month due to the additional effort of computer installation.

4.2.3 Assessment Conduct.

The actual assessment of the NCWF began in early August and proceeded until the first week of October (approximately 2 full months). Assessments at both sites (Delta Airlines and Comair) ran concurrently. Dispatchers used the NCWF operationally during normal work shifts. ACT-320 personnel collected user feedback through a variety of tools (see section 4.3) including questionnaires, interviews, operational observations, and user comment logs.

4.2.4 Assessment Schedule and Locations.

The NCWF Assessment was conducted from April through November 1999. This period included planning, preparation, coordination, and conduct. Planning, preparation, and coordination were primarily conducted at ACT-320 and NCAR facilities in Atlantic City, New Jersey; and Boulder, Colorado, respectively. Assessment conduct occurred at Delta Airlines' operations center in Atlanta, Georgia, and Comair's operations center at the Cincinnati International Airport, Covington, Kentucky. Table 1 provides an overall assessment schedule.

TABLE 1. NCWF ASSESSMENT SCHEDULE

Activity	Point of Contact	Date
Pre-assessment briefing at Comair	ACT-320, NCAR	April 28, 1999
Baseline data collection at Comair	ACT-320	June 1-2, 1999
Briefing and training at Delta	ACT-320, NCAR	June 7-9, 1999
Shakedown at Delta	NCAR	June 9 - August 6, 1999
Product installation at Comair	NCAR	July 10-11, 1999
Training for Comair	NCAR	July 12-14, 1999
Shakedown at Comair	NCAR	July 15 - August 6, 1999
Assessment conduct	ACT-320	August 7 - October 31, 1999
On-line log available to Delta	ACT-320	August 7 - October 7, 1999
Comair observations and start user log	ACT-320	August 10-11, 1999
On-site interviews at Delta	ACT-320	August 23-24, 1999
Telephone interviews with Delta	ACT-320	September 9, 1999
Questionnaire administered to Comair	ACT-320	October 6-7, 1999
On-line questionnaire to Delta	ACT-320	October 8-31, 1999
Debrief to NCAR and Comair	ACT-320	November 1, 1999

4.3 DATA COLLECTION AND ANALYSIS METHODS.

NCWF objectives were measured by obtaining feedback from airline dispatchers at Delta and Comair airlines. Data collection methods, described in the following sections, are documented in the NCWF Assessment Procedures, July 15, 1999.

4.3.1 User Logs.

User logs were employed to record dispatcher comments on a daily basis during the assessment period. The logs were designed to help identify specific instances of product performance along with the date and time of the occurrence. Log entries were also used to formulate interview and questionnaire material.

Delta Airline dispatchers used an on-line log that was developed by ACT-320 personnel (see appendix B). Dispatchers were able to complete the log by providing information on the perceived accuracy of the NCWF, ease of use, effect on dispatch tasks, and additional comments. At the end of log completion, dispatchers were able to submit their completed comments to ACT-320 electronically. While the on-line format was appropriate for Delta, paper logs were developed for use by Comair dispatchers (see appendix C). While Comair dispatchers had access to the Internet for viewing the NCWF, the availability of only 4 computers for the approximately 10 dispatchers on shift at any one time, made access to the Internet for log completion impractical. Thus, paper logs were prepared and distributed to each dispatcher work location. Comair dispatchers completed the logs by providing handwritten comments on the performance and use of the NCWF. A Comair representative collected completed logs and provided them via Federal Express to ACT-320.

4.3.2 Operational Observations.

ACT-320 personnel scheduled operational observations at Comair on August 10-11, 1999. The intent was to observe dispatchers' use of the NCWF during periods of convective weather. The observations were designed to be nonintrusive to dispatch operations and were coordinated with dispatch management prior to the actual visit. Observation logs were developed to record how and under what circumstances the product was used, whether other products were used, and any feedback from the observed dispatcher. Although convective weather was anticipated, none occurred. Therefore, observational data was not obtained. However, discussions with a number of dispatchers about the NCWF were conducted. Results of these discussions were summarized and included with information obtained by other methods.

4.3.3 Dispatcher Interviews.

ACT-320 personnel conducted on-site and telephone interviews with Delta Airlines dispatchers. The intent of the on-site interviews was to solicit information that was not being received via the user logs. A total of seven dispatchers were interviewed on-site to help determine dispatcher use of the NCWF. In addition, phone interviews were conducted when ACT-320 personnel observed convective weather that may have been impacting Delta flights. ACT-320 personnel monitored the weather by utilizing an Aircraft Situation Display (ASD) configured to display Delta Airline flights overlaid with a national weather radar mosaic. Telephone interview questions are located in appendix D.

4.3.4 Questionnaires.

ACT-320 personnel developed a questionnaire that was administered to both Delta Airlines and Comair dispatchers at the end of the assessment phase. The purpose of the questionnaire was to rate the utility, readability, and accuracy of the NCWF components and features, and rate the usefulness of the NCWF for dispatcher job tasks. In addition, open-ended questions provided dispatchers the opportunity to provide additional comments, suggestions for improvements, and enhancements. A copy of the questionnaire is included in appendix E. The questionnaire was administered electronically via the ACT-320 web page to Delta participants, while Comair participants were administered paper copies. Most of the Comair responses were provided during a visit by ACT-320 personnel who oversaw the administration of the questionnaire and were available for clarifications or questions.

4.3.4.1 Utility, Readability, and Accuracy.

As part of the questionnaire, dispatchers were asked to rate the NCWF on the three dimensions of utility, readability, and accuracy using a 5-point Likert scale. NCWF components and features were rated on all or a subset of the three dimensions. Items rated were:

a. Initial Detection Fields
b. Convective Intensity Color Scale
c. Detection Field Colors
d. 1-Hour Forecast Contours
e. 2-Hour Forecast Contours
f. Forecast Direction Lines
g. 50 nmi Range Rings
h. Airport Identifiers
i. Storm Top Information
j. Echo Speed
k. ARTCC Boundary Overlays
l. User Selected Zoom
m. NCWF Update Rate

The rating scale provided to the dispatchers consisted of the following:

a. 1 = Largely Acceptable. This response indicates the NCWF component being assessed consistently enhances your ability to meet the requirements of your job; likely to lead to enhanced job performance.

b. 2 = Acceptable. This response indicates the NCWF component being assessed frequently enhances your ability to meet the requirements of your job; may lead to enhanced job performance.

c. 3 = Borderline. This response indicates that, although the NCWF component being assessed is adequate, minor improvements would make it more helpful in identifying and forecasting convective weather, and does not degrade or improve job performance.

d. 4 = Unacceptable. This response indicates the NCWF component being assessed frequently impedes your ability to meet the requirements of your job; may lead to degradation of job performance.

e. 5 = Largely Unacceptable. This response indicates the NCWF component being assessed consistently impedes your ability to meet the requirements of your job; likely to lead to degradation of job performance.

Following the rating questions, open-ended questions were used to solicit comments as well as suggestions for improvement.

4.3.4.2 Usefulness to Tasks.

Another aspect of the questionnaire involved dispatcher assessment of NCWF usefulness in relation to operational tasks. Tasks were identified via baseline data collection and verified by dispatch management. A 5-point Likert scale was used to measure NCWF usefulness regarding the following specific tasks:

a. Preparing flight plans,
b. Planning fuel quantity,
c. Planning flight route,
d. Avoidance of severe convective weather,
e. Selecting an alternate airport,
f. Selecting altitude,
g. Monitoring flight conditions,
h. Re-routing flights,
i. Advising pilots enroute of severe convective weather,
j. Anticipating ground delays, and
k. Anticipating Air Traffic Control (ATC) actions (e.g., rerouting, closing runways, changing arrival gates).

The rating scale included the following:

a. 1 = Of Considerable Use. This response indicates the NCWF had a significant positive effect on decisions and activities related to the performance of this task.

b. 2 = Somewhat Useful. This response indicates the NCWF had a positive effect on decisions and activities related to the performance of the task.

c. 3 = Borderline. This response indicates the NCWF had little to no effect on decisions and activities related to the performance of the task.

d. 4 = Of Little Use. This response indicates the NCWF had a negative effect on decisions and activities related to the performance of the task.

e. 5 = Not at all Useful. This response indicates the NCWF had a significant negative effect on decisions and activities related to the performance of the task.

4.3.5 Data Analysis.

Much of the feedback from the user logs, observations, interviews, and questionnaire was in the form of comments, answers to open-ended questions, and interview responses. These responses were recorded and are summarized in the results section (section 5).

Since response to the user logs was limited (see section 5.1), the majority of the assessment results are based on questionnaire responses. Questionnaire data was analyzed using descriptive statistics. Rating scores data is ordinal and is not normally distributed; therefore, the median was used as a measure of central tendency. The median is the value above and below which one half of the observations fall. When there is an even number of observations, no unique center value exists, so the mean of the two middle observations is taken as the median value. For the questionnaire rating data, low median values (near 1 and 2) indicated generally positive feedback, while high values (4 and 5) indicated negative feedback. Rating scale response percentages were also calculated.

5. RESULTS.

5.1 FACTORS AFFECTING RESULTS.

a. Small Response Set: The number of questionnaire responses from Delta airlines was limited. Even though Delta participation was limited to 10 Subject Matter Experts, only 5 of these participants responded. Whether these responses are representative of Delta, or airline dispatchers in general, is questionable, as this number may not be considered statistically significant. Additionally, Delta did not provide any user log responses noting specific instances of product performance. Based on this limited feedback, it is difficult to ascertain Delta's actual opinion of the NCWF.

b. User log responses were limited for both Delta and Comair: As noted above, Delta did not provide any user log responses, while Comair provide only 11 log responses out of a total dispatcher population of approximately 40 individuals working 7 days a week over the nearly 2-month period when the user log was available. Thus, most of the results of the assessment are based on rating information from the questionnaire, supplemented by comments.

c. Lack of Operationally Significant Convective Weather: According to dispatchers and product developers, significant convective weather activity was not prevalent throughout the assessment period. Although there were some occurrences of significant convective weather, the NCWF may not have had a chance to be fully utilized.

5.2 QUESTIONNAIRE RESULTS.

Overall questionnaire results for both airlines are discussed below. Individual airline results are discussed in subsequent sections.

5.2.1 Overall Dispatcher Results.

5.2.1.1 Utility, Readability, and Accuracy Ratings.

Results of the utility, readability, and accuracy ratings for the NCWF components are presented in table 2. Note that not all components were rated on all three dimensions. Results are shown using the median and the percentage of responses for each possible rating.

The majority of NCWF components received an overall rating of 2 (acceptable) or above on all three dimensions (utility, readability, and accuracy). Utility of the airport identifiers and ARTCC boundary overlays were rated highest overall with a median score of 1 (largely acceptable).

Four of the NCWF components received overall ratings of 3 (borderline), indicating that the component was adequate, but minor improvements would make it more helpful. These four were:

a. The 1-hour forecast contours accuracy,
b. The 2-hour forecast contours utility,
c. The 2-hour forecast contours accuracy, and
d. The product update rate.

Half (50 percent) of the responses indicated that the accuracy of the 1-hour forecast contours was borderline. Although accuracy of the 2-hour forecast contours received an overall borderline rating, over 37 percent of respondents rated this component as unacceptable or largely unacceptable. Thus, over 1/3 of the respondents indicated that this component impedes their ability to meet job requirements and leads to degradation of job performance. While both the 1- and 2-hour forecast contours were rated as borderline, the forecast direction lines and echo speed both received overall ratings of 2 (acceptable).

5.2.1.2 Job Task Ratings.

Results of the usefulness of the NCWF for dispatcher job tasks are presented in table 3. Median rating scores were mostly positive with a median score of 2 (somewhat useful) for 8 of the 11 task categories. These results indicate that the NCWF had a positive effect on decisions and activities related to the performance of the following job tasks:

a. Planning flight plans,
b. Planning flight routes,
c. Avoidance of severe convective weather,
d. Selecting an alternate airport,
e. Selecting altitude,
f. Monitoring flight conditions,

TABLE 2. OVERALL RATINGS FOR NCWF COMPONENTS

COMPONENT	Median	1 = Largely Acceptable %N	2 = Acceptable %N	3 = Borderline %N	4 = Unacceptable %N	5 = Largely Unacceptable %N	Total N
1. Initial Detection Fields							
a. Utility	2	34.3	51.4	14.3			35
b. Readability	2	25.0	69.4	5.6			36
c. Accuracy	2	16.7	55.6	22.2	5.6		36
2. Convective Intensity Color Scale							
a. Utility	2	41.7	50	8.3			36
b. Readability	2	36.1	50	13.9			36
3. Detection Field Colors							
a. Utility	2	41.2	50	5.9	2.9		34
b. Readability	2	35.3	52.9	8.8	2.9		34
4. 1-Hour Forecast Contours							
a. Utility	2	22.2	47.2	27.8	2.8		36
b. Readability	2	27.8	55.6	16.7			36
c. Accuracy	3	11.1	30.6	50.0	8.3		36
5. 2-Hour Forecast Contours							
a. Utility	3	14.3	31.4	37.1	17.1		35
b. Readability	2	17.1	60	14.3	8.6		35
c. Accuracy	3	5.7	14.3	42.9	25.7	11.4	36
6. Forecast Direction Lines							
a. Utility	2	17.6	47.1	26.5	8.8		34
b. Readability	2	17.6	52.9	20.6	8.8		34
c. Accuracy	2	9.1	45.5	30.3	15.2		33
7. 50 nm Range Rings							
a. Utility	2	34.3	37.1	25.7	2.9		35
b. Readability	2	41.2	47.1	11.8			34

TABLE 2. OVERALL RATINGS FOR NCWF COMPONENTS (Continued)

COMPONENT	Median	1 = Largely Acceptable %N	2 = Acceptable %N	3 = Borderline %N	4 = Unacceptable %N	5 = Largely Unacceptable %N	Total N
8. Airport Identifiers							
a. Utility	1	55.6	44.4				36
b. Readability	2	41.7	38.9	19.4			36
9. Storm Top Information							
a. Utility	2	47.2	38.9	11.1	2.8		36
b. Readability	2	22.2	52.8	22.2	2.8		36
c. Accuracy	2	20.0	53.3	26.7			30
10. Echo Speed Values							
a. Utility	2	35.3	47.1	17.6			34
b. Readability	2	17.6	50.0	29.4	2.9		34
c. Accuracy	2	11.8	58.8	29.4			34
11. ARTCC Boundary Overlays							
a. Utility	1	51.5	30.3	12.1	3.0	3.0	33
b. Readability	2	39.4	42.4	12.1	6.1		33
12. User Selected Zoom							
a. Utility	2	42.9	22.9	34.3			35
b. Readability	2	32.4	41.2	20.6	5.9		34
13. Product Update Rate	3	17.1	20.0	48.6	14.3		35

Also included are the percentage responses of each rating and the total number of responses (N). Blank information indicates no responses for the particular rating. See section 4.3.4.1 for a description of the rating scale.

TABLE 3. OVERALL RATINGS FOR NCWF USEFULNESS TO JOB TASKS

TASK	Median	1 = Of Considerable Use %N	2 = Somewhat Useful %N	3 = Borderline %N	4 = Of Little Use %N	5 = Not at all Useful %N	Total N
Preparing Flight Plans	2	27.3	51.5	15.2	6.1		33
Planning Fuel Quantity	3	17.6	23.5	38.2	17.6	2.9	34
Planning Flight Route	2	38.2	47.1	11.8	2.9		34
Avoidance of Severe Convective Weather	2	36.4	51.5	9.1	3.0		33
Selecting an Alternate Airport	2	18.2	45.5	18.2	18.2		33
Selecting Altitude	2	2.9	8.8	41.2	35.3	11.8	34
Monitoring Flight Conditions	2	17.6	52.9	20.6	8.8		34
Re-routing Flights	2	32.4	52.9	11.8	2.9		34
Advising Pilots Enroute of Severe Convective Weather	2	27.3	48.5	21.2	3.0		33
Anticipating Ground Delays	3	12.5	28.1	40.6	18.8		32
Anticipating ATC Actions	3	6.9	27.6	44.8	6.9		29

Also included are the percentages of each response and the total number of responses (N). Blank information indicates no responses for the particular rating. See section 4.3.4.2 for a description of the rating scale.

g. Rerouting flights, and
h. Advising pilots enroute of severe convective weather.

Three of the task areas received a borderline rating of 3, indicating the NCWF had little to no effect on the performance of the tasks. These tasks were:

a. Planning fuel quantity,
b. Anticipating ground delays, and
c. Anticipating ATC actions.

5.2.1.3 Comments.

Questionnaire comments regarding improvements and product issues are addressed under individual airline sections.

5.2.2 Delta Airline Dispatcher Questionnaire Results.

As mentioned in section 5.1, Delta Airline dispatchers provided a limited number of questionnaire responses. In addition, it was identified during interviews that even among the Subject Matter Experts, some dispatchers were using the older 1998 version of the NCWF. Thus, much of the Delta questionnaire feedback has to be viewed as inconclusive.

5.2.2.1 Delta Airlines Utility, Readability, and Accuracy Rating Results.

Table 4 displays the questionnaire rating results for Delta Airlines. Results were not generally consistent with overall questionnaire results. Delta ratings tended to be higher, indicating a more positive view of the NCWF's interfaces and components. However, as noted, the small sample size from Delta (N=5) may or may not be considered representative of the Delta dispatcher population.

For each of the 13 NCWF components, median ratings were 2 (acceptable) or higher for the three dimensions of utility, readability, and accuracy. It was further noted that 60 percent (18 of 30) of the component ratings were 1 (highly acceptable), indicating that most of the NCWF components were viewed by the dispatchers as consistently enhancing their ability to meet job requirements or were likely to lead to enhanced job performance.

TABLE 4. DELTA AIRLINES' RATINGS FOR NCWF COMPONENTS

COMPONENT	Median	1 = Largely Acceptable %N	2 = Acceptable %N	3 = Borderline %N	4 = Unacceptable %N	5 = Largely Unacceptable %N	Total N
1. Initial Detection Fields							
a. Utility	1	100					5
b. Readability	1	60	20	20			5
c. Accuracy	1	80	20				5
2. Convective Intensity Color Scale							
a. Utility	1	100					5
b. Readability	1	60	40				5
3. Detection Field Colors							
a. Utility	1	80	20				5
b. Readability	1	60	40				5
4. 1-Hour Forecast Contours							
a. Utility	1	80	20				5
b. Readability	1	60	20	20			5
c. Accuracy	2	40	60				5
5. 2-Hour Forecast Contours							
a. Utility	1.5	50	50				4
b. Readability	1.5	50	50				4
c. Accuracy	1.5	50	50				4
6. Forecast Direction Lines							
a. Utility	1	80	20				5
b. Readability	2	40	40	20			5
c. Accuracy	2	40	60				5
7. 50 nm Range Rings							
a. Utility	2	40	20	40			5
b. Readability	1	60	40				5

Also included are the percentage responses of each rating and the total number of responses (N). Blank information indicates no responses for the particular rating. See section 4.3.4.1 for a description of the rating scale.

TABLE 4. DELTA AIRLINES' RATINGS FOR NCWF COMPONENTS (Continued)

COMPONENT	Median	1 = Largely Acceptable %N	2 = Acceptable %N	3 = Borderline %N	4 = Unacceptable %N	5 = Largely Unacceptable %N	Total N
8. Airport Identifiers							
a. Utility	1	60	40				5
b. Readability	2	20	40	40			5
9. Storm Top Information							
a. Utility	1	80	20				5
b. Readability	2	40	40	20			5
10. Echo Speed Values							
a. Utility	1	80	20				5
b. Readability	2	40	40	20			5
c. Accuracy	2	40	40	20			5
11. ARTCC Boundary Overlays							
a. Utility	1	60	40				5
b. Readability	2	20	80				5
12. User Selected Zoom							
a. Utility	1	100					5
b. Readability	1	60	40				5
13. Product Update Rate	1	80		20			5

5.2.2.2 Delta Airlines Job Task Rating Results.

As shown in table 5, Delta Airline dispatchers' overall rating scores were positive for the usefulness of the NCWF in performing job tasks. Using the median of the responses, the NCWF was rated as 1 (highly useful) in the following five areas:

a. Preparing flight plans,
b. Planning fuel quantity,
c. Avoidance of severe convective weather,
d. Monitoring flight conditions, and
e. Rerouting flights.

All other tasks received ratings of 2 (somewhat useful) with the exception of "Anticipating ATC actions," which received a rating of 3 (borderline).

5.2.2.3 Delta Airlines Comments and Enhancements.

Generally, Delta comments on the NCWF focused on the need for an animation capability (in order to see trend information) and additional overlays such as aircraft routes and navigational fixes.

Suggestions were given for improving the readability of graphics and colors. A desire for larger images, as well as use of different colors to better delineate forecast contour lines were suggested. While these comments appear to be inconsistent with the questionnaire ratings, where readability was rated positively on all components (see section 5.2.2.1), the questionnaire responses did include several borderline ratings for readability, suggesting that minor improvements would make the NCWF more helpful (see table 4).

Comments regarding the accuracy of the forecasts and storm top data were provided. One user reported that on several occasions, no forecasts were available for VIP level 3 or higher activity when it was felt that forecasts should be available (note that this may be a result of the forecast criteria in section 3.1 not being met). Slow product updates and reliability issues were also identified (although problems with reliability were to be expected due to the experimental nature of the NCWF). The dispatcher comments appear to be inconsistent with the questionnaire ratings on the product update rate and forecast accuracy which were rated 1 (largely acceptable) or 2 (acceptable).

Positive aspects of the NCWF included the usefulness of the forecasts; the advantage of the NCWF as a single feature product; the graphical depiction of convection; and overall satisfaction with the day-to-day performance of the NCWF during the thunderstorm season.

Full questionnaire comments by Delta Airline dispatchers are available in appendix F.

TABLE 5. DELTA AIRLINES' RATINGS FOR NCWF USEFULNESS TO JOB TASKS

TASK	Median	1 = Of Considerable Use %N	2 = Somewhat Useful %N	3 = Borderline %N	4 = Of Little Use %N	5 = Not at all Useful %N	Total N
Preparing Flight Plans	1	60	20	20			5
Planning Fuel Quantity	1	60	20	20			5
Planning Flight Route	2	40	40	20			5
Avoidance of Severe Convective Weather	1	60	20	20			5
Selecting an Alternate Airport	2	40	40	20			5
Selecting Altitude	2		80	20			5
Monitoring Flight Conditions	1	60	40				5
Re-routing Flights	1	100					5
Advising Pilots Enroute of Severe Convective Weather	2	40	40	20			5
Anticipating Ground Delays	2	40	40	20			5
Anticipating ATC Actions	3	40		40	20		5

Also included are the percentages of each response and the total number of responses (N). Blank information indicates no responses for the particular rating. See section 4.3.4.2 for a description of the rating scale.

5.2.3 Comair Dispatcher Questionnaire Results.

Approximately 30 dispatchers from Comair provided responses to the questionnaire. The responses are summarized in the following sections.

5.2.3.1 Comair Utility, Readability, and Accuracy Rating Results.

Comair questionnaire rating results for NCWF utility, readability, and accuracy are shown in table 6. While results for the NCWF components were not as high as Delta's, the majority of components were still rated 2 (acceptable) and higher. However, a review of the percentage responses indicates that a number of Comair dispatchers felt that many of the NCWF components were in need of improvement (i.e., a borderline rating). The following items received overall ratings of 3 (borderline):

a. The 1-hour forecast contours accuracy,
b. The 2-hour forecast contours utility,
c. The 2-hour forecast contours accuracy,
d. The forecast direction lines accuracy, and
e. The product update rate.

A significant number of respondents (67 percent) indicated that the 1-hour forecast contours accuracy was either 3 (borderline) or 4 (unacceptable). According to the rating scale definitions, both borderline and unacceptable are negative ratings. In addition, the ratings of the 2-hour forecast contours should be noted. An overall rating of 3 (borderline) for utility and accuracy was provided with a substantial number of respondents indicating a 4 (unacceptable) rating.

5.2.3.2 Comair Job Task Rating Results

Job task rating results for Comair are shown in table 7. Usefulness ratings were mostly positive with the NCWF receiving a median rating of 2 (somewhat useful) for 7 of the 11 task areas. Unlike Delta responses, no tasks received a rating of 1 (of considerable use). However, the seven task areas that received the somewhat useful rating were overwhelmingly positive, with over 60 percent of the respondents rating the NCWF as "Of Considerable Use" or "Somewhat Useful." The following three of the seven task areas had over 80 percent of the respondents rating the NCWF positively:

a. Planning flight route,
b. Avoidance of severe convective weather, and
c. Rerouting flights.

The following four task areas received borderline ratings (indicating that the NCWF had little to no positive effect upon the task):

a. Planning fuel quantity,
b. Selecting altitude,

TABLE 6. COMAIR RATINGS FOR NCWF COMPONENTS

COMPONENT	Median	1 = Largely Acceptable %N	2 = Acceptable %N	3 = Borderline %N	4 = Unacceptable %N	5 = Largely Unacceptable %N	Total N
1. Initial Detection Fields							
a. Utility	2	23.3	60	16.7			30
b. Readability	2	19.4	77.4	3.2			31
c. Accuracy	2	6.5	61.3	25.8	6.5		31
2. Convective Intensity Color Scale							
a. Utility	2	32.3	58.1	9.7			31
b. Readability	2	32.3	58.1	9.7			31
3. Detection Field Colors							
a. Utility	2	34.5	55.2	6.9	3.4		29
b. Readability	2	31.0	62.1	3.4	3.4		29
4. 1-Hour Forecast Contours							
a. Utility	2	12.9	51.6	32.3	3.2		31
b. Readability	2	22.6	61.3	16.1			31
c. Accuracy	3	6.5	25.8	58.1	9.7		31
5. 2-Hour Forecast Contours							
a. Utility	3	9.7	29.0	41.9	19.4		31
b. Readability	2	12.9	61.3	16.0	9.7		31
c. Accuracy	3	12.9	45.2	29.0	12.9		31
6. Forecast Direction Lines							
a. Utility	2	6.9	51.7	31	10.3		29
b. Readability	2	13.8	55.2	20.7	10.3		29
c. Accuracy	3	3.6	42.9	35.7	17.9		28
7. 50 nm Range Rings							
a. Utility	2	33.3	40.0	23.3	3.3		30
b. Readability	2	37.9	48.3	13.8			29

TABLE 6. COMAIR RATINGS FOR NCWF COMPONENTS (Continued)

COMPONENT	Median	1 = Largely Acceptable %N	2 = Acceptable %N	3 = Borderline %N	4 = Unacceptable %N	5 = Largely Unacceptable %N	Total N
8. Airport Identifiers							
a. Utility	1	54.8	45.2				31
b. Readability	2	45.2	38.7	16.1			31
9. Storm Top Information							
a. Utility	2	41.9	41.9	12.9	3.2		31
b. Readability	2	19.4	54.8	25.8			31
c. Accuracy	2	20.0	53.3	26.7			30
10. Echo Speed Values							
a. Utility	2	27.6	51.7	20.7			29
b. Readability	2	13.8	51.7	34.5			29
c. Accuracy	2	6.9	62.1	31.0			29
11. ARTCC Boundary Overlays							
a. Utility	1.5	50.0	28.6	14.3	3.6	3.6	28
b. Readability	2	42.0	35.7	14.3	7.1		28
12. User Selected Zoom							
a. Utility	2	33.3	26.7	40.0			30
b. Readability	2	27.6	41.4	24.1	6.9		29
13. Product Update Rate	3	6.7	23.3	53.3	16.7		30

Also included are the percentage responses of each rating and the total number of responses (N). Blank information indicates no responses for the particular rating. See section 4.3.4.1 for a description of the rating scale.

TABLE 7. COMAIR RATINGS FOR NCWF USEFULNESS TO JOB TASKS

TASK	Median	1 = Of Considerable Use %N	2 = Somewhat Useful %N	3 = Borderline %N	4 = Of Little Use %N	5 = Not at all Useful %N	Total N
Preparing Flight Plans	2	21.4	57.1	14.3	7.1		28
Planning Fuel Quantity	3	10.3	24.1	41.4	20.7	3.4	29
Planning Flight Route	2	37.9	48.3	10.3	3.4		29
Avoidance of Severe Convective Weather	2	32.1	57.1	7.1	3.6		28
Selecting an Alternate Airport	2	14.3	46.4	21.4	17.9		28
Selecting Altitude	3	3.4	10.3	34.5	37.9	13.8	29
Monitoring Flight Conditions	2	10.3	55.2	24.1	10.3		29
Re-routing Flights	2	20.7	62.1	13.8	3.4		29
Advising Pilots Enroute of Severe Convective Weather	2	25.0	50.0	21.4	3.6		28
Anticipating Ground Delays	3	7.4	25.9	44.4	22.2		27
Anticipating ATC Actions	3		33.3	45.8	12.5	8.3	24

Also included are the percentages of each response and the total number of responses (N). Blank information indicates no responses for the particular rating. See section 4.3.4.2 for a description of the rating scale.

c. Anticipating ground delays, and,
d. Anticipating ATC actions.

The Planning Fuel Quantity task was most disparately rated between the two airlines. Delta users indicated the NCWF was of considerable use in performing this task, whereas the Comair response was borderline. Interview information indicated that from the dispatchers' standpoint, it was very difficult to anticipate ATC actions, regardless of any product availability.

5.2.3.3 Comair Comments and Enhancements

Comair questionnaire comment summaries are located in appendix G. The comments are summarized in the following paragraphs.

a. Forecast Accuracy

Several respondents commented on the NCWF's forecast accuracy, especially the inaccuracy of the 2-hour forecast. In addition, it was noted that the NCWF performed poorly when isolated storm cells or air-mass conditions were present. Part of this performance was, as noted by some dispatchers, due to inherent limitations in the NCWF forecast algorithm. One dispatcher suggested that for air-mass type storms, other inputs (e.g., lifted indices, outflow boundaries, or winds aloft) could enhance the accuracy and overall usefulness of the NCWF.

In addition to the accuracy, it was noted that the 1- and 2-hour forecast contours tended to vary a great deal from one update to another. As an example, one dispatcher related an incident where the NCWF forecast a storm to move east, then south, then alternated between east and south. In actuality, the storm moved southeast.

Two dispatchers indicated that the product tracked "phantom" or nonexistent storms. ACT-320 personnel observed a similar situation and noted that the forecast contours were current, but the detection field was outdated. This was brought to the attention of NCAR personnel who believed it to be a software problem.

These comments are consistent with Comair's questionnaire ratings, where forecast accuracy for both the 1- and 2-hour forecasts received borderline scores.

b. Readability

The following issues with readability were identified:

1. Annotations such as echo speed, storm tops, and airport identifiers were difficult to read either because they were too small or surrounding detection fields obscured the annotations. It was suggested that larger print be used. While questionnaire rating results indicated that 25 and 34% of the respondents gave

borderline ratings to the storm height and echo speed, respectively, overall readability ratings for storm height and echo speed were acceptable (i.e., positive).

2. The display screen was too cluttered, especially when viewing the NCWF on the national scale with all components and overlays visible.

3. The update time needs to be made more pronounced on the display.

4. The 50-nmi range rings were squashed into ovals. NCAR personnel stated that the distortion of the circular range rings was due to the map projection used.

c. Reliability

The NCWF was unavailable on many occasions due to system outages or slow, inconsistent updates. This was somewhat to be expected due to the experimental nature of the product and due to the NCAR facilities, which are designed for research purposes, rather than the operational maintainability of products. While the product reliability affected dispatchers' perceptions of the usefulness (as determined by comments), the extent of the effect was not measured.

In addition to reliability, respondents reported that data updates were too slow, especially during dynamic, convective, weather situations. Based upon interview comments, it is believed that dispatchers are referring to the reliability of the NCWF, not that an actual update rate faster than 5 minutes is needed, however, this has not been confirmed.

The comments are consistent with Comair questionnaire results where the median score for update rate acceptability was borderline.

d. Zoom

Users reported problems with using the zoom function. One noted difficulties controlling enlargement. Another found that the zoom box was difficult to see. One indicated that re-zooming an image back to the national map was cumbersome and a progressive zoom feature was preferred (although the "previous zoom" feature appears to already give this capability, see section 3.2.2.1). These comments are consistent with questionnaire results regarding the readability and utility of the zoom function. While both dimensions received overall ratings of acceptable, 40 percent of users rated the zoom utility as borderline and 31 percent rated the zoom readability as borderline or unacceptable.

e. Animation

Over one-third of the Comair users indicated that looping or animation would enhance the utility of the NCWF in order to see movement, growth, decay, and aid in predicting future storm locations. The ability to animate appears very important as one user stated a live radar loop with top reports is just as, if not more, useful than the NCWF.

f. Other Enhancements and Comments

It was suggested that the NCWF should add growth and decay components to see where and when storms will build and dissipate.

Two dispatchers reported that the NCWF was valuable as a supplemental tool, but could not be relied on exclusively.

One respondent noted the NCWF's greatest use was in detecting current storm locations and intensity levels; yet also found the 1-hour forecast a useful tool.

Various dispatchers made suggestions for additional overlays. These included:

1. User defined routes (routes provided with the NCAR web page were straight lines and did not reflect actual Comair flight routes);

2. Displayed flight routes to the Bahamas, navaids, and user selected airports and VORs;

3. Wind directions.

5.2.4 Delta Airlines and Comair Questionnaire Differences.

Comparisons of median ratings between Delta and Comair airlines regarding dimensions of utility and accuracy of the 2-hour forecast are of special interest. While Comair rated these dimensions "borderline," Delta's median scores were considerably higher, with an overall median of 1.5, indicating an acceptable to highly acceptable view on all dimensions of the 2-hour forecast.

Ratings on update rates between the two airlines were also disparate. Delta considered the NCWF update rates largely acceptable, whereas Comair assigned a borderline rating to this product component. However, as already stated, Comair ratings may have been more applicable to the actual product reliability rather than the update rate.

In regards to usefulness to job tasks, Delta's responses tended to be higher (more positive) than Comair's.

5.3 NONQUESTIONNAIRE FEEDBACK.

5.3.1 Comair User Log Comments.

The few comments provided via the User Log were provided by Comair dispatchers and dealt mainly with the maneuvering of aircraft in relationship to convective weather. It was twice noted that a decision was made to not reroute aircraft based on forecast information provided by the NCWF. In both cases, aircraft were able to stay on

schedule, rather than make time-consuming reroutes. Other User Log information included:

a. The existence of phantom cells (see section 5.2.3.3; Forecast Accuracy),
b. Inconsistent echo tops information,
c. No forecasts with thunderstorms associated with Hurricane Dennis,
d. No forecasts with a slow moving line.

5.3.2 Comair Observations.

ACT-320 personnel observed Comair dispatchers during normal operations to note use of the NCWF. While the observations were planned in the anticipation of convective weather, no significant convection occurred. Therefore, observational data was not obtained. However, there were discussions with a number of dispatchers about the NCWF.

According to dispatcher comments, the NCWF generally identified convection. However, due to air mass conditions and rapid growth and decay, the forecast component was not always generated.

Generally, the NCWF appeared to be an asset. Positive comments included:

a. Easily accessed,
b. Useful addition to existing products,
c. Good planning tool,
d. Range rings useful for determining distances, and
e. Useful with lines of convection.

Criticism of the NCWF was as follows:

a. Forecast not always displayed,

b. Forecasts were displayed without any accompanying detection field,

c. Need to be close to display to see graphics and text,

d. Forecasts need to be more accurate. It appears the NCWF does not assimilate enough of the current storm situation and dynamics.

Suggested enhancements were:

a. Animation,
b. Extend geographical coverage,
c. Distance indicator or calculator,
d. User selected flight routes,
e. Display lightning information,

f. Increase size of annotations,
g. Include intensity in the forecast,
h. User selected cities and navigational aids.

An instance of beneficial NCWF use was identified. A Comair pilot had requested an additional passenger in lieu of fuel reserves. Using the NCWF, the dispatcher noted the likelihood of convection along the route, which could have lead to a diversion. Thus, fuel levels were maintained.

5.3.3 Delta Airlines Interviews.

5.3.3.1 On-Site.

On-site interviews were conducted with a limited number of Delta Airline dispatchers. Relevant feedback consisted of the following:

a. Utility:

1. The NCWF was useful for planning and for enroute decisions concerning the identification and status of alternate airports.

2. Echo tops were important to determine whether an aircraft could fly over a convective area.

3. The timeliness of the NCWF was better than existing operational products.

b. Display:

1. Echo tops information and airport identifiers contributed to a cluttered display. For the echo tops, it was identified that perhaps a clicking on the displayed storm for relevant data would be useful, although the availability of the echo tops information without user intervention was good. It was recommended that when an airport and a NAVAID of the same name were located near each other, that only one needed to be displayed.

2. The time format of hh.mm.ss was confusing. For example, 18.00.00 was interpreted as 00 Coordinated Universal Time (UTC) on the 18th of the month, rather than 18 UTC.

3. The availability of more airports and NAVAIDS was recommended.

4. It was recommended that NCWF be merged with Integrated Terminal Weather System (ITWS) and ASD information.

c. Zoom:

1. Zoom function was unwieldy, often appearing to give a different area than what was selected.

2. A predetermined step function for zooming in and out was requested, along with a pan feature.

3. The predetermined ARTCC regions of the 1998 NCWF version were requested together with the user-specified zoom of the 1999 version.

d. Accuracy:

1. It was noted that the NCWF was extremely accurate for large, organized storms, but not so for air mass storms.

e. Reliability:

1. The NCWF would often drop forecasts, only to have them reappear several updates later. (Note that according to the forecast criteria, this appears to indicate a software problem rather than an inherent feature of the NCWF algorithm.)

2. Echo top information was often sporadic in availability, which decreased its utility.

5.3.3.2 Telephone Interviews.

Based on telephone interview data, two instances of beneficial product use were identified:

a. The NCWF displayed a break in what ATC personnel considered a solid line of thunderstorms. Based on the NCWF information, the dispatcher was able to route three aircraft through the break.

b. The NCWF displayed convection in an area not displayed by the WSI radar display. The dispatcher had his aircraft avoid the area, although other aircraft attempted to fly through. He observed that these latter aircraft ultimately had to be diverted due to thunderstorm activity.

In addition:

a. Echo tops were helpful, for example, by indicating when a storm was diminishing.

b. Storm motion vectors were helpful in determining when storms would impact a destination city or a route.

c. The NCWF appeared to perform well on organized squall lines, but had problems with air mass thunderstorms and Florida sea-breeze initiated storms.

d. NAVAIDs on map tend to obscure views, especially with NAVAIDs and airports displayed on top of one another.

6. CONCLUSIONS.

The following sections summarize conclusions in response to individual assessment objectives.

a. Objective: *Assess the value of the National Convective Weather Forecast (NCWF) in identifying and forecasting convective weather for airline dispatch use.*

Results indicate that the NCWF does provide value in identifying convective weather. Questionnaire responses on the utility of the initial detection field were predominantly positive. Results concerning the forecast of convective weather, however, were mixed. The perceived value of the 1- and 2-hour forecasts differs significantly between the two airline dispatch groups. Comair rated the utility of the 2-hour forecast as borderline whereas Delta's rating was very positive (i.e., largely acceptable). Accuracy of the 1-hour forecast, rated borderline by Comair personnel, received an acceptable rating from Delta. The borderline rating of the 2-hour forecast utility may be correlated to the perceived accuracy of the product; that is, less accuracy equals less utility.

Feedback from open-ended comments and verbal interactions provided additional insight into the value of the NCWF. Dispatchers indicated the NCWF was useful and that the graphical representation of both real-time and forecast convection was very helpful. However, Comair responses indicated the NCWF was valuable as an additional piece of information rather than a stand-alone product. In addition, issues regarding the accuracy of the forecast components, especially the 2-hour forecast, lessened the NCWF's value in forecasting convective weather.

b. Objective: *Identify NCWF benefit areas for dispatcher tasks and decisions.*

Based on questionnaire rating results, the NCWF appears to benefit most dispatcher tasks and decisions. Overall results indicate the NCWF provides benefit or usefulness in the following areas:

1. Preparing flight plans,
2. Planning flight routes,
3. Avoidance of severe convective weather,
4. Selecting an alternate airport,
5. Selecting altitude,
6. Monitoring flight conditions,
7. Rerouting flights, and
8. Advising pilots enroute of severe convective weather.

Both airlines were consistent in rating the benefit of the NCWF to "anticipating Air Traffic Control (ATC) actions" as borderline. Dispatcher comments appear to indicate that anticipating ATC actions simply are not possible.

Comair rated more task areas as borderline than Delta. Most disparate among these were "planning fuel quantity." Whereas, Delta found the NCWF "highly useful," Comair rated the NCWF as having little or no effect in performance of this task. This disparity could be a function of the individual airlines' operational procedures, type of aircraft flown, extent of control over the aircraft's planned flight route, or the small number of Delta responses.

c. Objective: *Assess product graphical interface and characteristics.*

Overall readability ratings from the questionnaire were acceptable for all components with little difference noted between the two airlines. While rating results indicated acceptability, comments indicated that some dispatchers preferred a larger image with larger annotations and a more pronounced and clearer date and time indication. Dispatcher comments also included the tendency for the NCWF display to become cluttered when all components and overlays were selected. The zoom function elicited several comments concerning the awkwardness of its use and the desirability for predetermined steps and Air Route Traffic Control Center (ARTCC) regions: however, it should be noted that awkwardness might be a familiarity or training issue.

d. Objective: *Assess NCWF performance and accuracy from the dispatchers' perspective.*

Questionnaire rating results indicated an overall borderline response for the accuracy of the 1- and 2-hour forecast contours. From the dispatchers' perspective, the accuracy of the NCWF forecasts needs improvement. While the perspective of the 1-hour forecast was that minor improvements would make it more helpful, a significant portion of the assessment dispatchers found the 2-hour forecast unacceptable. In contrast, questionnaire results for the direction lines and echo speed were acceptable. Based upon dispatcher comments, the disparity between the forecasts and the direction lines and echo speed may be indicative of the lack of convective growth and decay elements. It may be that the direction and speed are correct, but changes in area coverage and/or new growth are leading to the borderline responses for the forecast contours. It was noted that the product appears to handle large, organized storms (especially line storms) in an accurate manner. The performance with smaller, air mass storms is not as good.

Other performance factors included the lack of and variability of forecasts. This appeared to be either a result of reliability problems or the inherent forecast criteria of the NCWF. Forecasts are not produced unless storms meet certain size and longevity criteria. Dispatchers noted that forecast contours could vary substantially from one update to another. This varying tended to diminish confidence in the accuracy of the NCWF.

e. Objective: *Identify enhancements.*

The most frequently noted enhancements are as follows:

1. Improved accuracy of the 1- and 2-hour forecasts.
2. Animation to enhance the utility of the NCWF.
3. Growth and decay of convective areas.
4. Larger graphics and text.
5. Improved zoom capability.
6. Additional overlays, including:
   (a) User defined flight routes, and
   (b) Additional Navigational Aids (NAVAID).

f. Other:

Poor reliability of the NCWF was a negative issue. Although reliability was not addressed in the assessment, problems like down-time and presentations of old data may have influenced participants' perception of the product. The borderline rating given to the product update rate may be more of an indication of product reliability. This was supported by comment information and interviews where dispatchers noted that the product was not always available. Since the NCWF was an experimental product, its availability could not be ensured on a 24-hour per day, 7-day per week basis. Users tended to interpret unavailability as an inherent problem of the product itself. However, it should be noted that written comments identified product update issues to the extent that data updates are too slow and therefore not synchronized with real-time conditions. This is especially important when considering rapidly changing conditions inherent with some convective weather situations.

Participation from Delta Airlines was disappointing. Although the participating assessment group was small, commitment from each participant and management was assumed based upon coordination both before and during the assessment. However, there were no user log responses and only five completed questionnaires. The lack of involvement causes uncertainty with respect to how representative the Delta data was.

7. RECOMMENDATIONS.

a. It appears the National Convective Weather Forecast (NCWF) product concept is useful for airline dispatcher use. The product interface appears to be acceptable, although a few modifications could be performed.

b. The strongest criticism of the NCWF is in regards to its accuracy of the 1- and 2-hour forecasts. Further development should concentrate on improved accuracy of the forecasts, including the incorporation of growth and decay capabilities.

c. The assessment provided support for the utility of the NCWF product concept to airline dispatch operations. Further work should be performed with Air Traffic Control (ATC) facilities in order to provide a similar convective forecasting capability, enhancing shared situation awareness between dispatch and controller functions.

8. ACRONYMS.

ACSF	Automated Convective SIGMET Forecast
ACT-320	Weather Branch at the FAA Technical Center
ARTCC	Air Route Traffic Control Center
ASD	Aircraft Situation Display
ATC	Air Traffic Control
AWC	Aviation Weather Center
AWRP	Aviation Weather Research Program
dB	decibels
FAA	Federal Aviation Administration
ITWS	Integrated Terminal Weather System
km	kilometers
NAVAID	Navigational Aid
NCAR	National Center for Atmospheric Research
NCWF	National Convective Weather Forecast
NLDN	National Lightning Detection Network
nmi	nautical miles
NOAA	National Oceanic and Atmospheric Administration
PIREP	Pilot Report
RAP	Research Applications Program
SIGMET	Significant Meteorological Statements
TITAN	Thunderstorm Identification Tracking and Nowcasting
UTC	Coordinated Universal Time
VHF	Very High Frequency
VIL	Vertically Integrated Liquid
VIP	Video Integrated and Processor
VOR	VHF OmniRange Navigation System
WSI	Weather Services International
WSR-88D	Weather Surveillance Radar – 1988 Doppler

APPENDIX A

COMAIR BASELINE INFORMATION

1. Background:

In support of the NCWF 1999 assessment, baseline data collection was conducted at Comair Airlines from June 1 – 2, 1999 at airline headquarters at the Cincinnati International Airport, Covington, Kentucky. Eight dispatchers were interviewed. In addition, a Lead Dispatcher and the Duty Manager, Flight Operations gave an overview of Comair operations, which is summarized below.

Comair is the largest regional airline in the USA and a regional carrier for Delta Airlines. It operates nearly 700 daily flights. The airline is headquartered at the Cincinnati/Northern Kentucky International Airport. Comair has flights between 80 cities in 28 states and 3 countries (Nassau, the Bahamas, and Canada). Flight routes encompass Montreal, Canada to the North; Key West and Nassau to the South; Bangor, Maine to the East; and Colorado Springs to the West.

The airline, to date operates 2 aircraft types: 1) Canadair Regional Jet (CRJ) and 2) Embraer Brasilia (EM2). The CRJ is a 50 passenger turbofan aircraft. To date 76 CRJs are in operation. Comair intends to buy 50 additional CRJs over the next year with future options to obtain 115 more. The airline plans to phase out the smaller turboprop EM2s that carry up to 30 passengers. Currently there are 25 EM2s operating.

2. Organization of Aircraft Operations Center:

Dispatchers are located in the Systems Operations Control Center (SOCC). The SOCC consists of Operations and Technical Support. Dispatch falls under Operations and shares the SOCC area with crew schedulers, maintenance coordinators, flight controllers, and flight followers.

In the dispatch area there are four duty managers, two lead dispatchers and approximately eight regular dispatchers. Dispatchers are not assigned flights based on aircraft type or geographical location, like other airlines, but by lines of flight. These schedules appear to be arbitrarily computer generated and are rotated from day to day. Typically, the dispatcher will not know until the day before which lines he/she will be controlling. The exception to this is the lead dispatcher who has taken over the newly created shuttle desk. He/she will handle the same flights daily. Generally each individual dispatcher handles 40 to 50 flights a day. Shifts are broken out as follows: 4 am – 2 pm; 5 am – 3 pm; 6:30 am – 4:30 pm; 8:45 am – 5:45 pm; 1:30 pm – 11:30 pm; 2:45 pm – 12:45 am; and 6:30 pm – 4:30 am. Operations typically end at 1:00 am and resume at 5:30 am. There are a few overnight charters.

There is one ATC liaison known as the flight controller. The flight controller communicates with ATC centers, TMUs and the Command Center. There are scheduled telecons with the Command Center and Centers at 8:15 am and 12:30 pm. Generally issues like weather conditions, booking levels and VIP operations are discussed.

The dispatcher interfaces with a number of individuals who are responsible for various aspects of the flight and for providing important information. For example, the scheduling coordinator will inform the dispatcher of changes in crews at least 2 hours in advance. The maintenance planner provides information on restrictions on the MEL (minimum equipment list), any equipment problems, and what aircraft have undergone maintenance. The maintenance coordinator, located next to the flight controller, also passes on maintenance information such as aircraft maintenance status. The flight controller or supervisor oversees all dispatch

activities and provides information such as cancelled flights, crew changes, aircraft changes, and late arriving flights. Flight followers generally monitor all flights and pass on status changes, flow control messages, or other information that may be related to a flight.

3. Dispatch Workspace Configuration:

Resources (hardware and software) available to dispatchers and other dispatch personnel include the following:

Deltamatic – Standalone display with flight follower application providing flight information, flight times, payloads messages, etc. This is available to each dispatcher.

X: Terminal – PC providing applications such as Kavouras radar, flight release software and Netscape Internet browser. Dispatchers can also receive e:mail messages, over the airline's intranet. Most internal information/messages are disseminated in this manner. This is available to each dispatcher.

Air to ground radio – This is used to communicate to flights enroute that are in range – range extends from Cincinnati to Orlando, FL. Beyond Orlando (Comair's 2nd hub) enroute radio communication is patched via telephone. This is available to each dispatcher.

ASD – Aircraft Situation Display is used to graphically follow flights; especially those that are not followed on the Deltamatic. The application can provide status on all flights and is useful in determining how ATC is routing traffic. Weather radar overlays, locators, and distance calculators make this a very useful resource. However, there is only one ASD located on the far side of the room, near the lead dispatcher area.

4. Preparing Flight Plans:

The flight plan is automatically generated via the WXAIR system. The dispatcher only needs to enter the captain's name and aircraft number. The system will then generate the preferred route, contingency fuel levels, weight restrictions, preferred speed (via forecast winds), and current and forecast weather both enroute and at the destination city. Weather parameters can be integrated into the program in terms of intensity and types of weather. This cuts down on the amount of text the pilot must read – filtering out the less critical or superfluous information. Weather sources include SIGMETs, AIRMETs, forecast winds, and advisories. PIREPs can be added if desired. The dispatcher chooses an alternate airport (if required). The flight plan is prepared 2 hours prior to flight and issued 1 hour in advance. If situations change (e.g., changes in weather along route) the flight plan can be amended. If enroute, the dispatcher can radio the pilot and verbally advise of the change. If the aircraft is still on the ground, the dispatcher can call the station. If necessary, messages to the pilot can be left at the gate using the RIDS application.

A summary of the flight plan is sent to ATC's data center. The flight crew will call ATC if the flight plan changes.

Workload is heaviest during the "pushes". There are 4 pushes: from 8 am – 8:40 am; 10 am – 10:40 am; 12 pm – 12:40 pm and 2 pm – 2:40 pm. The 8am and 2 pm pushes include the highest number of aircraft - thus the heaviest dispatch workload.

5. Enroute Monitoring:

Kavouras radar is used to monitor flight routes. If weather is severe, traffic management (ATC) can be called to discuss flight route options – available openings in the weather. PIREPS are

also referenced and pilots are encouraged to call in. Also, PIREPs listed on the Deltamatic are accessed. These are updated every hour. Indianapolis and Chicago enroute Centers handle 75 – 80% of Comair flights.

Only flights to and from Colorado Springs and Nassau require pilots to call in. Generally weather is monitored for enroute flights and messages are exchanged if weather conditions change significantly. Pilots are required to call dispatch if there has been an ATC reroute. Under this circumstance, the dispatcher will issue another plan with new calculations for optimal fuel burn. When flight plans change, the dispatcher must have other optional plans on hand.

6. Weather:

Generally, weather information sources include the following:

a. Kavouras radar composites with 30 – 40 minute animations,
b. Displays of individual NEXRADs,
c. Convective SIGMETS (textual),
d. PIREPs,
e. Tower information regarding ground fog,
f. Weather Channel (not an official source),

In addition to the above information, dispatchers were interviewed and asked about weather sources used; how flight planning and monitoring tasks are performed; and requirements they would have for an automated convective detection and forecast product. The following sections contain a summary of their responses.

7. Weather Sources:

a. What weather sources are available to you?
b. Which do you use most - or find most expedient or reliable?
c. What is your primary source(s) for convective weather information? Why?

Title	Response
Dispatcher 1	1) SIGMETS; 2) AIRMETs; 3) Briefing from previous dispatcher; 4) Self-brief by looking at the available weather information ; 5) 300-250 mb charts displaying temperature, icing and winds aloft; 6) Area Forecasts – 12 to 24 hours; 7) METARS and TAFS throughout the shift; 8) Composite radar (used mostly for routing – to see if there's any gaps in the weather); 9) NEXRAD; 10) Jet stream maps (mostly in winter); and 10) PIREPS - PIREPs are especially useful for icing
Dispatcher 2	1) Radar mostly – both composite and NEXRAD. 2) SIGMETs which are mentally plotted; and 3) PIREPs (sometimes).
Dispatcher 3	1) Radar composites to see how fast the weather is moving; 2) SIGMETs (to see speed and the direction of movement); 3) Radar reports (being phased out by NWS); 4) Maximum tops (very important information); 5) NEXRAD (to look for holes and see how close – cannot calculate distances now – mostly guess work); 6) METARS; 7) TAFs, and 8) PIREPS (occasionally, especially if they are from Comair crews).
Dispatcher 4	1) Kavouras radar (regional display); 2) Current radar with infrared satellite overlay. Has difficulty discerning radar colors in terms of high intensity (browns, reds, et al) especially between levels 3 and 4; and 3) METARs. Reported problems switching between different weather information sources – too timely. Needs to know how weather will develop. Uses individual NEXRADs on approaches in winter, however prefers regional radar views.
Dispatcher 5 (Lead)	1) Kavouras composite radar with airports and VORs overlaid; 2) NEXRAD for selected cities (though not good for broader picture); 3) Infrared satellite (to make decisions on finals and whether to head east or west); 4) PIREPS over the route of flight (from Jeppeson system); and 5) ASD (for shared situational awareness – can see if other planes have flown through a questionable route and then confirm with the TMU at the corresponding Center).
Dispatcher 6	1) Animated radar composite – from the past hour; 2) NEXRAD (to check stations and get a closer focus – also to see holes in weather); 3) Convective SIGMETs (to see how fast the weather is moving and get tops, speed and mileage rings); and 4) PIREPs (for tops and movement – also can get distances from the pilots).
Dispatcher 7	1) Convective SIGMETs (for direction, speed, tops); compare to Kavouras radar and try to guess where the weather will be in 2 hours although cannot account for increase or decrease in cell intensity or when cells will dissipate; 2) NEXRAD radar for comparison of PIREPs along the flight route, especially if they're going through an area of thunderstorms- and to get cell tops.
Dispatcher 8	1) Surface analysis charts (for fronts – obtained via Kavousas – not updated enough); 2) Composite radar (to see where fronts have moved); 3) 300 mb chart (with jet stream, winds, turbulence); 4) Weather depiction chart; 4) Release sheet (monitor where flight is and narrow down the view); 5) NEXRAD for Cincinnati; 6) Non-graphical SIGMETs (draws mental picture); 7) Individual city forecasts; 8) METARs; 9) TAFs; and 10) PIREPS.

8. Flight Planning:

a. Describe typical activities in preparing a flight plan.
b. Who do you interface with? How?
c. What weather information sources do you use (if different from above)? Why?

Title	Response
Dispatcher 1	1) First look at aircraft - passenger and cargo loads. 2) Checks weather to determine the route of flight, alternates, weights and the ability to carry extra fuel. 3) Checks CSLs and MELs for the performance of the aircraft to see if altitude drop is necessary – and will check again to see if weights are within weight criteria. 4) Checks in on flight to get the most recent information from the airport. 5) If necessary, modifies weather reports based on TAFs, NOTAMS and PIREPs.
Dispatcher 2	1) Makes sure that the previous flight has arrived on time 2) Looks at fueling requirements 3) Checks the weather (most important activity, especially if reroutes are required).
Dispatcher 3	1) Checks routes to see where flights will be 2) Checks weather by looking at: METARs; TAFs; PIREPs; Winds Aloft; SIGMETs; CWAs; to see how the weather's moving and how to get around it.
Dispatcher 4	Generally given 12 to 13 lines of flights. 1) Receives briefing from previous dispatchers; 2) Tries to get ahead on releases – prepare them ahead of time – so that there is more time for the unexpected. (needs to know what's going to happen in the next 2-3 hours); 3) looks at weather on the radar; 4) Checks MELS; 5) Automatic download of flight plan one hour before the flight departs; 6) Continues to monitor weather.
Dispatcher 5 (Lead)	1) Looks at where flights are arriving and departing on an ongoing basis; 2) Checks radar for current weather and calculates payload and booking effects - with short hauls between Boston and NYC has to handle ½ the lines of other dispatchers. Shuttles use CRJs – Brasilias and are used for 1 hr. hauls – mostly in Florida.
Dispatcher 6	1) Looks at weather – AIRMETs, SIGMETs, outlooks; graphical weather (12 hour forecast and prognosis); 2) Checks MELs that system brings up; 3) Issues flight plan 1 hour prior to departure.
Dispatcher 7	1) Verify crew names on X windows; 2) Checks Kavouras radar; 3) Looks at WXAIR system for TAFs, METARs, etc.; 4) Uses Deltamatic as a reference for passenger loads and if the flight is on time; 5) Checks satellite imagery for a better weather view.
Dispatcher 8	1) Checks destination weather; 2) Checks passenger loads; 3) Checks if "round-tripping" is feasible; 4) With worsening weather conditions, will communicate to station personnel; 5) Discuss alternate routes with the pilot.

9. Flight Replanning:

a. Describe typical activities in replanning a flight plan once an aircraft is enroute due to weather avoidance, mechanical problems, traffic delays, etc.
b. Who do you interface with? How?
c. What are the criteria for changing plans, e.g., how bad does the weather have to be?
d. How specifically does severe/significant convective weather along a flight route affect flight replanning?

Title	Response
Dispatcher 1	1) Check what has changed – looks at Deltamatic, maps, and routes – generally relies on radar; 2) Tries to vector aircraft around where storm will be; 3) Calculates intersections (rerouting program doesn't calculate intersections); 4) Reads new fuel burns over the phone to the pilot; 5) Makes amendments to the original release; 6) Makes note on release for the amendment.
Dispatcher 2	1) Safety of flight is # 1 concern; 2) Sees how ATC is routing; 3) recalculates and issues new fuel burn numbers; 4) Checks radar for weather conditions; 5) Briefs pilot – ATC route may not be good – may ask pilot to request another route; 6) Looks at SIGMETs to see how to calculate fuel burn; 7) Continues to check radar with animation.
Dispatcher 3	1) Call crews if enroute; 2) Checks radar; 3) Coordinates with flight crew – asks them to check their radar and help make a decision; 4) Look for reasonable alternate route; 5) See if ATC will allow another route; 6) Make fuel burn recalculations.
Dispatcher 4	1) Receives call from the pilot if radar is showing red; 2) Most concerned with Brasilias, since they cannot carry much fuel; 3) Confers with pilots on potential reroutes; 4) Can redispatch flight or pull up old release and replan.
Dispatcher 5 (Lead)	1) If conditions worsen 30 minutes to 1 hour before the flight, can contact the pilot on the ground; 2) Calls to say there is a new SIGMET and advises of possible reroute; 3) If ATC puts in new program, then reroutes are decided; 4) New fuel burn is calculated; 5) Check weather radar for clear air; 6) Will sometimes confer with pilot.
Dispatcher 6	1) Uses Deltamatic reroute screen; 2) Confers with flight crew.
Dispatcher 7	1) If anticipated, will load extra fuel; 2) Plans reroutes; 3) ATC may be holding even if weather is good, i.e. traffic saturation.
Dispatcher 8	1) Prepare reroutes - uses redispatch screen to come up with new routes; 2) Use WXAIR system to check weather conditions; 3) Confers with pilot; 4) Calls center TMUs.

10. Flight Monitoring:

a. Describe typical activities while monitoring flights, e.g., assessing weather conditions enroute and at destination airports?
b. Who do you interface with? How? When?
c. What information sources (i.e., weather) do you use? Why?

Title	Response
Dispatcher 1	1) Checks ASD display; 2) Check in and out times at gates to see if late or on time; 3) With appearance of heavy convective weather will a) monitor ASD; b) try to see where ATC is routing other flights; c) see where flights are lined up; d) contact flight crew on Delta's radio; e) issue bulletins; f) has flight follower disperse information to other dispatchers.
Dispatcher 2	If good day, no need to do much monitoring. If weather is bad, will monitor SIGMETs. May look at the ASD to see if other aircraft are getting through. Ability to click weather on and off on the ASD display is very helpful.
Dispatcher 3	If there is weather, will look at the Deltamatic to check on flights – see if they've arrived on time. Will call the crew when unexpected weather or turbulence appears.
Dispatcher 4	1) Checks ASD often – sometimes there are gaps but it is usually accurate; 2) Overlays weather; 3) Overlays other flights; 4) Relays information to pilots – especially if there are areas (holes) to fly through; 5) Uses Deltamatic flight follower in conjunction with ASD and checks departure and arrival times; 6) Looks at TOAST options for additional information; 7) Uses air to ground radio to contact flight crew.
Dispatcher 5 (Lead)	1) When monitoring during bad weather wants to know where aircraft are; 2) checks flights in relation to weather; 3) Looks at ASD display; 3) Uses Deltamatic as the primary information source for enroute monitoring; 4) Requires crew to call in if encountering bad weather.
Dispatcher 6	1) Monitors closely when weather is bad; 2) Checks Deltamatic to see if flights arrived and departed on schedule; 3) Looks at ASD; 4) Rechecks weather and fuel loads.
Dispatcher 7	1) Watches each flight; 2) Checks on arrival/departure times – if flight is 30 minutes late, will note on the flow sheet; 3) Looks at Deltamatic; 4) Checks ASD and determines why flights are holding.
Dispatcher 8	1) Tracks each flight using a flow sheet; 2) Checks arrival/departure times on Deltamatic; 3) Uses TOAST system; 4) Checks ASD.

11. What would you like to see in a convective detection and forecast product?

Title	Response
Dispatcher 1	1) Ability to see holes and gaps in the weather; 2) Mileage key to calculate distances; 3) Individual storm cell vectors; 4) Storm Vectors; 5) Navaids overlay (user selectable).
Dispatcher 2	1) Tops; 2) Storm movement; 3) Strength (intensity) of storm.
Dispatcher 3	1) Tops; 2) Forecast – at least 1 hour; 3) Storm movement; 4) Overlays of VORs, jet routes, and arrival and departure gates
Dispatcher 4	1) Overlay VORs and significant cities; 2) Overlay product on ASD;
Dispatcher 5 (Lead)	1) Cloud tops – may aid in understanding the presence of turbulence; 2) Doppler radar – to see horizontal wind shear; 3) Height of cloud layers; 4) Lightning data.
Dispatcher 6	1) Overlay VORs; 2) Show 6 levels of weather; 3) Same look as composite radar; 4) Tops; 5) Animation; 6) Storm movement.
Dispatcher 7	1) Weather briefing from meteorologists; 2) Growth and decay; 3) Overlays of VORs and jet routes.
Dispatcher 8	1) Forecast of 1 to 1 ½ hours; 2) Storm velocity; 3) Tops; 4) Flight routes overlaid with radar; 5) Capability to overlay weather charts.
Dispatcher 9 (Lead)	1) Heights of cloud layers ; 2) Plotted Convective SIGMETs; 3) Cloud tops; 4) Geographical locators; and 5) Distance calculators.

APPENDIX B

DELTA AIRLINES USER LOG

NATIONAL CONVECTIVE WEATHER FORECAST (NCWF) MONITORING LOG FOR DELTA AIRLINES' DISPATCHERS

Instructions: Please take a few minutes to write down your impressions of the NCWF. The log has been broken out into four general sub-areas for your consideration: 1) Perceived Accuracy; 2) Ease of Use; 3) Effect on Dispatch Task(s); and 4) Additional Comments. Please be specific regarding: geographical locations; flight routes effected; weather phenomena encountered; and types and sources of information used.

Responses to this log will remain anonymous and confidential. No individual will be associated with any comments.

PLEASE PROVIDE THE FOLLOWING INFORMATION.

Name or identifier: _____ Title: _____

Type of haul (check one): Short Medium Long Other _____

PERCEIVED ACCURACY:

EASE OF USE:

EFFECT ON DISPATCH TASK(S):

ADDITIONAL COMMENTS:

APPENDIX C

COMAIR USER LOG

NCWF PRODUCT PERFORMANCE LOG

DATE:_____ TITLE: _____

TIME	DEP/ARR POINTS	CONVECTIVE WX TYPE*	CRJ or EMB	COMMENTS: PLEASE COMMENT ON HOW THE PRODUCT PERFORMED AND HOW YOU USED IT; I.E. REROUTES, FUEL DECISIONS.

*CONVECTIVE WX TYPE = LINE STORMS, AIR MASS, STATIC, RAPIDLY CHANGING

APPENDIX D

DELTA AIRLINE TELEPHONE INTERVIEW QUESTIONS

Telephone Interview Questions

a. It appeared that convective activity occurred from (time of onset – time of offset). Is that true? Were you anticipating it?

b. How did this weather affect your flights?

c. During this time, how did you use the NCWF or think it could be used/applied?

d. How did the NCWF perform for you? Can you recall examples of that performance?

   1) If good or bad, how did you know? For example, did you compare it to pilot reports (PIREPS) or ASD data?

   2) Did this performance affect your confidence in the accuracy of the product? If so, how was your confidence affected?

   3) In this situation, which product components did you find most useful? Why?

e. How did use of the product impact your tasking or dispatch activities?

f. What problems did you encounter (e.g., reading text; obscuration of data; zooming; navigation; differentiating colors and intensity levels; updates too fast or slow)?

g. Is there anything else you would like to add?

APPENDIX E

DISPATCHER QUESTIONNAIRE

1999 NATIONAL CONVECTIVE WEATHER FORECAST (NCWF) ASSESSMENT

DISPATCHER QUESTIONNAIRE

Prepared by:

Communication/Navigation/Surveillance
Engineering and Test Division, Weather Branch, ACT-320
William J. Hughes Technical Center
Federal Aviation Administration
Atlantic City International Airport
Atlantic City, NJ 08405

Please provide the following information:

Airline:_____ Title:_____

Delta Participants: Please check or indicate the dispatch area you cover

Short Haul____ Medium Haul____ Long Haul____ Other_____

Instructions

The purpose of this questionnaire is to obtain feedback from airline dispatchers regarding the National Convective Weather Forecast (NCWF) product. The Aviation Weather Research Branch at the FAA's William J. Hughes Technical Center is conducting the assessment of the NCWF product.

Feedback from dispatchers is a very important component of the assessment, and responses to this questionnaire will provide important information for use in future iterations of the NCWF product. Please respond to all questions as honestly and thoroughly as possible.

All responses will remain ANONYMOUS and CONFIDENTIAL. A report will be written on the results of this questionnaire, however, no one will be identified or associated with any specific comment. **Please return the questionnaire to the FAA's Technical Center Evaluator or designated representative.**

Rating Scale Definitions

The five-point scale below should be used to rate the NCWF. The following definitions are provided for use when assessing the product. Please refer to these definitions when responding. Also, for your reference, a color print of the NCWF display has been provided to aid in relating specific questions to the components of the display.

(1) Largely Acceptable - This response indicates the product/component being assessed consistently enhances your ability to meet the requirements of your job; likely to lead to enhanced job performance.

(2) Acceptable - This response indicates the product/component being assessed frequently enhances your ability to meet the requirements of your job; may lead to enhanced job performance.

(3) Borderline - This response indicates that, although the product/component being assessed is adequate, minor improvements would make it more helpful in identifying and forecasting convective weather and does not degrade job performance.

(4) Unacceptable - This response indicates the product/component being assessed frequently impedes your ability to meet the requirements of your job: may lead to degradation of job performance.

(5) Largely Unacceptable - This response indicates the product/component being assessed consistently impedes your ability to meet the requirements of your job; likely to lead to degradation of job performance.

NA - you have never used the product/component in question.

Other Definitions

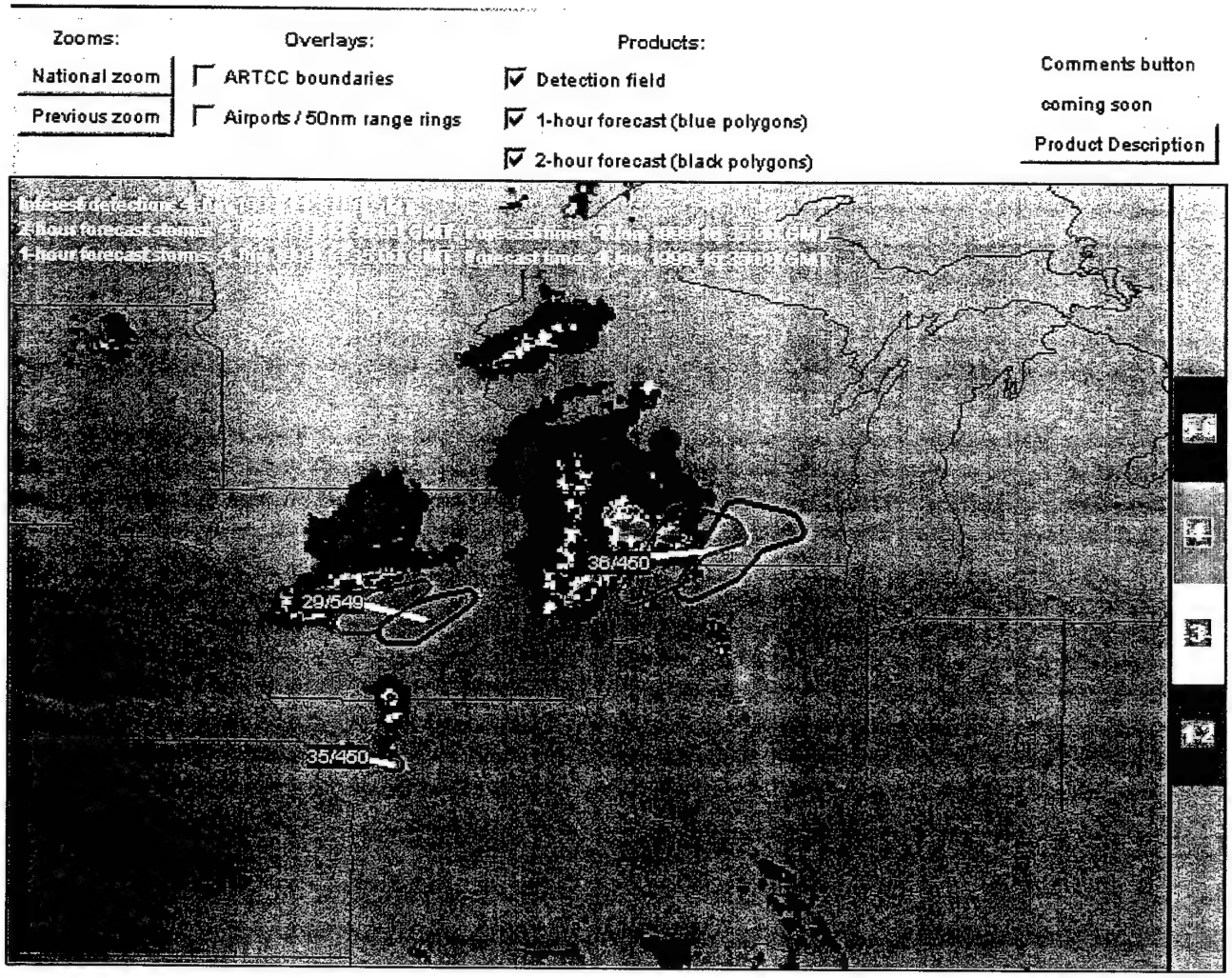
You will be asked to rate the NCWF and its components along the dimensions of utility, readability, and accuracy. The following definitions should be considered when answering questions.

(1) Utility – This refers to the usefulness of the product/ component in meeting job requirements and responsibilities.

(2) Readability - This refers to how readable or legible the product or feature is (for example, display clutter, font size, color coding).

(3) Accuracy – This refers to the extent the user perceives the accuracy of the identification and forecasting of areas of convective weather.

NCWF Products and Components



Instructions: Please rate the National Convective Weather Forecast product and its components by circling the appropriate number.

National Convective Weather Forecast Product	Largely Acceptable	Acceptable	Borderline	Unacceptable	Largely Unacceptable	
1. Initial Detection Fields						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
c. Accuracy	1	2	3	4	5	NA
2. Convective Intensity Color Scale						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
3. Detection Field Colors						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
4. 1-Hour Forecast Contours						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
c. Accuracy	1	2	3	4	5	NA
5. 2-Hour Forecast Contours						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
c. Accuracy	1	2	3	4	5	NA
6. Forecast Direction Lines						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
c. Accuracy	1	2	3	4	5	NA

National Convective Weather Forecast Product	Largely Acceptable	Acceptable	Borderline	Unacceptable	Largely Unacceptable	
7. 50 nmi Range Rings						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
8. Airport Identifiers						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
9. Storm Height Information						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
c. Accuracy	1	2	3	4	5	NA
10. Echo Speed Values						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
c. Accuracy	1	2	3	4	5	NA
11. ARTCC Boundary Overlays						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
12. User Selected Zoom						
a. Utility	1	2	3	4	5	NA
b. Readability	1	2	3	4	5	NA
13. Product Update Rate	1	2	3	4	5	NA

14. Additional Comments. Please provide any additional comments you may have regarding the above NCWF products and components.

15. List suggestions for improving any of the above NCWF products, functions or displayed items. Please identify the item in the suggestion(s).

16. List other attributes or components that you think should be added to the NCWF.

Product Usefulness for Job Tasks

Instructions: The five point scale below should be used to rank the usefulness of the NCWF on each of the tasks listed. Please refer to the following definitions when responding.

(1) Of Considerable Use. This response indicates the NCWF had a significant positive effect on decisions and activities related to the performance of this task.

(2) Somewhat Useful. This response indicates the NCWF had a positive effect on decisions and activities related to the performance of the task.

(3) Borderline. This response indicates the NCWF had little to no effect on decisions and activities related to the performance of the task.

(4) Of Little Use. This response indicates the NCWF had a negative effect on decisions and activities related to the performance of the task.

(5) Not at all Useful. This response indicates the NCWF had a significant negative effect on decisions and activities related to the performance of the task.

NA – You have never used the NCWF in performing this task.

	Of Considerable Use	Somewhat Useful	Borderline	Of Little Use	Not at all Useful	
17. Preparing flight plans.	1	2	3	4	5	NA
18. Planning fuel quantity.	1	2	3	4	5	NA
19. Planning flight route.	1	2	3	4	5	NA
20. Avoidance of severe convective weather.	1	2	3	4	5	NA
21. Selecting an alternate airport.	1	2	3	4	5	NA
22. Selecting altitude.	1	2	3	4	5	NA
23. Monitoring flight conditions.	1	2	3	4	5	NA
24. Re-routing flights.	1	2	3	4	5	NA
25. Advising pilots enroute of severe convective weather.	1	2	3	4	5	NA
26. Anticipating ground delays.	1	2	3	4	5	NA
27. Anticipating ATC actions (e.g., rerouting, closing runways, changing arrival gates)	1	2	3	4	5	NA
28. Other_____	1	2	3	4	5	NA

Thank you for your time and cooperation.

APPENDIX F

DELTA AIRLINES QUESTIONNAIRE COMMENTS

NCWF Questionnaire Comments
Delta Airlines

Dispatcher	Please provide any additional comments you may have regarding the NCWF and its components.
1	Biggest negative issue...product reliability, especially in high user demand times/strong convective activity periods. Also noted and reported several occurrences when forecast model was not indicating for VIP 3 or better activity. Reference 2 hour forecast contours: never saw this feature in action. Greatest advantage to this product is the one-stop feature, which eliminates the need to compare and cross-examine various single feature products available from other sources. This is a very nice product that just needs a little tweaking.
2	Perhaps the site should be separated into two parts...enroute and terminal. For instance 50nm rings are more useful enroute rather than a terminal environment. More airport zooms would be helpful as well. ITWS is a very good product but not enough coverage. At times the max tops data seems to be grossly inaccurate. I find the forecast contours very useful particularly when solid squall lines contours split and they are usually on target as far as forecasting a developing hole in the line.
3	I used this product every day during the thunderstorm season and was very pleased with its usefulness and performance. There were just a couple of readability issues with the graphics, otherwise - great tool.
4	Great graphics questionable accuracy due to slower updates at times; displays good but not real time at times

Dispatcher	List suggestions for improving any of the NCWF components, functions or displayed items. Please identify the item in the suggestions.
1	Color selection for forecast contour lines: suggest change the outline color or the background colors. Cyan appears to work better on a dark or black background color in my experience.
2	Most of the improvements I would make on the components are readability. Thankfully it's been some time since I had to use your product that I can't honestly give you a good example.
3	We use 24 inch monitors and run at a very high resolution. I would like to see a larger image option for users with very large screens.
4	More frequent updates a flight/dispatcher in the area has no real use for a 5 minute or even 2 minute update...how long is a leg or turn of a holding pattern...1 minute I think and that's as long as we need to wait for new data

Dispatcher	List other attributes or components that you think should be added to the NCWF.
1	Interface with the ATCSCC Severe Weather unit and display current/projected reroutes. 4-frame weather looping?
2	As previously stated, I think most of the readability issues would go away if the site contained more zooms.
3	I would like to see actual SWAP routes, which are in place by the ATCSCC graphically depicted on the map so that users could evaluate the viability of these routes collaboratively.
4	Fixes around the airport like the corner posts and maybe the IAF for active runways

APPENDIX G

COMAIR QUESTIONNAIRE COMMENTS

NCWF Questionnaire Comments
Comair Airlines

Dispatcher	Please provide any additional comments you may have regarding the NCWF and its components.
1	2-hour forecasts are not very accurate.
2	Live radar loop with top reports is just as, if not more, useful than this product.
3	Would like to see it update more often. The box for the zoom is difficult to see.
4	I found icing and storm top information extremely helpful in my planning procedures.
5	Forecast contours are too often inaccurate. Storm moves east for 10 minutes, then it moves south for 10 minutes and keeps going back and forth between the two, instead of showing the result of this, which was southeast.
7	Sometimes shows erroneous information.
8	Product sometimes tracked phantom storms when no weather existed.
9	It would be nice to have a setting to increase updates - especially on bad weather days and have last update time more pronounced. Have had times when I had a quick look at the screen for a radio call and began to give the wrong information.
10	Sometimes when there were many echoes, the speed and height indicators were difficult to read, as were the airport locators. We did get great benefit from the icing forecast.
11	While flight-planning decisions were not made based solely on the information provided, it is definitely a very useful and influential tool to have.
12	When product was up it was fairly useful. Placement of terminals hindered my use of product during high workloads. Also, lag time in initial forecast of new convective activity reduced the value of product during rapidly changing conditions. All in all, a decent supplemental source of information.
13	The areas of forecast icing are very helpful.
14	NCWF product has, on occasion, tracked phantom storms. These storms would appear on NCWF product but could not be found on other radar products. Time and date stamps matched on other products.
15	Product updates were poor when the storms or bad weather was around. A lot of the time it was old data. For preflight planning this product could be very useful.
16	1. intensity color scale - dispatchers needed constant reminders of color scale vs. a) NEXRAD and b) radsum charts. Confusion in interpreting differences. 2. NCWF was available to the dispatcher 75% to 80% of the day. However, it slowed when major storm systems generated. Information overload?
17	A couple of problems I had was controlling the enlargement of an area - it was difficult to control enlargement. I would have difficulty outlining the areas I wanted to view. Secondly, sometimes the updating would occur every few minutes or more often and sometimes change the one and track boundaries significantly. I would then lose confidence in the predictability. However, it is a great concept. I really can use the forecast to estimate weather and I did use it to reroute some aircraft. The ARTCC boundary overlays can be useful.

Dispatcher	Please provide any additional comments you may have regarding the NCWF and its components (continued).
18	I would like to see animation on the detection fields - possibly the last 2-6 hours of movement.
19	A couple of times the 1-hour forecast was changing constantly (every 5 minutes) as a system approached CVG. On occasion the system was down or not updating which caused me not to rely on it as often. The other products we had to use were there then, so it may have caused me to ignore what this had to offer when it was working.
20	I have found that with all of the components activated the screen is far too cluttered and confusing, the vectors are useless because they are nothing more than straight lines, the ARTCC outlines are of no use as well.
22	All in all, the system would rate a success in my eyes, for current storm location and intensity levels. The 1-hour forecast was a useful tool as well, the majority of the time.
24	The thunderstorm prediction algorithm is useful only to a point. It can track thunderstorms, but only after 45 minutes of level 3 data have been received. Also, the storm prediction tracks seem to follow only the path (instantaneous direction and speed) at the time of the prediction. It does seem to veer away due to other outside factors.
25	I like the tops and speeds given - very helpful!! I find the 1- and 2- hour forecast unreliable.
26	I feel it useful as a "second opinion". With an improvement in its predictions it could prove to be an extremely useful tool.
28	Zoom is very difficult to read. Reliability of system working would be needed.
30	Icing is great! The convective weather was down quite often and didn't portray any weather trends or development. Few tops were shown, and movement was shown for only a few cells. Development and trends weren't shown at all.
31	#4/#5 - Product is rated as such due to inherent limitations of trying to forecast airmass type thunderstorms based on extrapolated data. I have personally not seen this product on line during a frontal-type line, which, in my opinion, would work better.

Dispatcher	List suggestions for improving any of the NCWF components, functions, or displayed items. Please identify the item in the suggestion(s).
1	Would be useful to show movement of weather on this program. This might help us to better predict cell or storm movement.
4	Would be helpful if 2 hour forecast was more accurate.
5	NCWF was inoperable quite a bit. Needs to be a little more reliable.
6	The zoom function could be enhanced so that you could have a progressive zoom in/zoom out function rather than having to keep going back to the National zoom and re-zooming from there.
7	Easier to zoom in on a certain area would be nice.
9	Bigger print would be nice - frontal systems - great job. Isolated cells didn't perform as well.
10	Would help if we could just select the airports we wanted to see. Don't always need them all. Also would like to be able to select specific VORs (e.g., FLM, DXV, AIR)
11	The horizontal shearing of the 50nm range rings is confusing. Would have liked to have had the ability to show the information in a loop like most conventional radar imagery.
12	The routes on the map are useless because they are straight line, not the routes actually flown. Having the actual route and user definable routes (for use in reroutes) would be helpful. Overlays should be definable by user. When zoomed out, screen clutter was a problem.
14	Possibly add lightning strike data. One and two hour forecast contours tended to vary a great deal over several minutes, e.g., line thunderstorms 50 mi. west of MCI - 1 hour contour showed movement due west. Next update showed line of thunderstorms missing MCI 20 miles to the southwest. Storms did pass southwest as forecasted but initial contours showed westerly movement.
15	Use motion in depicting movement. Would give us a better perspective on how the storms were building.
16	Point and click to expand.
17	It would be nice to show a historical progression as well as its forecast projection. Information on icing and turbulence areas as well as improving the heights at precipitation readings would be greatly helpful. It would be great to be able to superimpose the route NAVAIDs on the map quickly.
18	Readability of many items could be improved (see items #7 - #10 of ratings).
19	The display for routes is useless since they are just straight lines and not the normal routing.
20	The display should be contained on one screen and should not require constant scrolling.
22	The 2-hour forecast could use some improvement in the accuracy field.
25	If the 1 and 2-hour forecasts were more reliable it would be a very nice system.
26	An integration with an ASD would be extremely useful as far as seeing what ATC may be doing or thinking.
28	Loop movement would be of great help.
30	A loop could help considerably.
31	• Displayed items - User selected NAVAIDS/Airports/Points of reference. • Function - For airmass activity, consideration of other normal forecast tools (i.e. lifted indexes, presence of outflow boundaries, winds aloft, etc.) would greatly enhance the accuracy (and thus usefulness) of this product.

Dispatcher	List other attributes or components that you think should be added to the NCWF.
1	Turbulence and icing data would be a nice option to access.
2	Radar loop (movement past hour).
3	An airline's canned routing, i.e. CVG to COS.
5	Airport arrivals would be nice (including along the chosen arrival). Also departures.
6	Further development of the product to add forecast of convective development would greatly enhance this product's usefulness.
9	Icing and turbulence would be nice.
10	SID and STARS. Jet routes to the Bahamas.
11	A raw lightning data loop (strike indicator). A linear scale for the base maps in nautical miles.
12	Integration with a regular radar package would enhance the product. Also, a looping feature would give some information of forecast accuracy for each storm system being tracked.
14	Echo speed and tops could be larger when viewing from wider scope (i.e. national zoom). Good product!
16	ATC does not use this system and ATC still relies on delay programs and ground stops 1 1/2 to 2 hours prior to a thunderstorm event. When using this system in planning CDM, ATC, while they will take input, tend to promote knee-jerk reactions to thunderstorm weather and disrupts operations without cause. What I mean by this is that ATC will do whatever they want and do what's in their interest as opposed to what's right.
18	If possible it would be nice to see areas of potential icing and/or turbulence mapped out on this map or an additional map.
19	A loop of past activity.
20	Progression over the past hour should be added. This would make it easier to show trend of intensities.
22	Something to indicate movement (immediate) and whether the storm is dissipating or building would help out tremendously.
28	VOR components added would help.
30	Maybe adding winds, directions and such as an overlay.